PRACTICES OF ART AND SCIENCE

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This dissertation explores the question of how art and science work as categories to circumscribe bodies of knowledge. I am interested in how specific knowledge communities label and materially shape artistic and scientific objects in contexts. People engage in rhetorical positioning through the creation of texts, style choices, making and unmaking the meanings of objects. Objects can be made to fit into the knowledge networks of art, science, or combinations of both. For different practitioners and audiences, what counts as art or science and their association vary in interesting ways. The categories of art and science serve many purposes. They indicate the kind of attention people, objects, and ideas want to elicit from readers, viewers, and thinkers. They serve to demarcate resources, to delineate interests, and to separate social groups.

This dissertation contains three core case studies: the story of the Blaschka's 19th century glass scientific models, the story of the 1990s tactical media movement, and the story of bioarts as practiced in a wet biological lab in Australia. These cases serve to show that art and science are not stable categories and demonstrate ways those categories are maintained. By unpacking the ways actors have used these categories, I complicate the division between the realms of art and science, be reflexive about thinking with regard to the categories we use to make sense of things and the value and power-orientation assigned to those categories, and show that science studies tools can be applied to artistic practice with fruitful results that

offer new ways of thinking about people and objects that have often fallen outside the scope of science studies research. My analysis details the forms of knowledge produced by art and science in these contexts.

BIOGRAPHICAL SKETCH

Hannah Star Rogers was raised in Goldhill, Alabama. She attended Lee-Scott Academy in Auburn, Alabama. She did her undergraduate work in English and Public Policy at Duke University, where she received highest honors for her poetry thesis under Dr. Jim Applewhite. It was in Applewhite's courses on science and poetry that she first began to consider questions about the relationship between science and the arts. After a year teaching high school in Macheng, China, she pursued her Ph.D. on intersections of art and science in the field of Science & Technology Studies under the direction of Dr. Judith Reppy at Cornell University.

FOR HIRAM, CRYSTAL, AND HUGO

WITHOUT WHOM NOTHING IS POSSIBLE AND

WITH WHOM EVERYTHING IS POSSIBLE.

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TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

What happens when we encounter the word "science" and replace it with "art" in our minds?

That element of arbitrariness does not, however, indicate that any artistic community could practice its trade without some set of received beliefs. Thomas Kuhn's *The Structure of Scientific Revolutions* (1970, 4).

The successive transition from one paradigm to another via revolution is the usual developmental pattern of mature **art** (Kuhn 1970, 12).

Men whose research is based on shared paradigms are committed to the same rules and standards for **artistic** practice (Kuhn 1970, 11).

Or "art" and replace it with "science"?

Science worlds consist of all the people whose activities are necessary to the production of the characteristic works which that world, and perhaps others as well, define as **science**. Howard Becker's *Art Worlds* (1982, 34).

Like other participants in the making of **science** works, the state and its agents act in pursuit of their own interests, which may or may not coincide with those of the **scientists** making the works. … The state pursues these interests both by supporting what it approves and by discouraging or forbidding what it disapproves—by intervening in the production of **science** it considers inimical to its interest ... (Becker 1982, 165-167)

Transposing art for science and vice versa raises questions about how we think about art and science. How do we tell science and art apart and what are the consequences of the possibility of blurring the two? Becker's view, if read as being about science, would sound very familiar to science studies scholars, who have learned to think of marginalized science not as a failure of a truth claim, but rather as an issue of social marginalization (Collins and Pinch 2008). Indeed, Becker's concept of "worlds" has been employed by scholars in relation to the sciences by Elihu Gerson (1983), Adele Clarke (1998), Susan Leigh Star (1995; Bowker and Star 1999), and Joan Fujimura (1996). Becker's worlds are networks in which materials

and people associated with art circulate. Galleries, studios, and museums contain multitudes of artists, patrons, and art-going publics encountering materials and rhetorics, and labeling things as art and non-art to varied effects.

Kuhn writes about periods of normal science and periods of paradigm shifts. This model also applies to art, where periods of sustained similar art making inside and among various schools and sub-disciplines are interrupted by extreme changes in form and content. A comparison of Kuhn's and Becker's careful studies of their respective knowledge communities reveals that a great deal can be understood about art and science by understanding the social context in which each is produced. It is the social difference, created by our system of labeling and categorizing acts of knowledge-making, which will concern me in this dissertation. This dissertation will make the case that in the terms of science studies scholars – that is, those in which the practices of laboratory technicians and traditional medicine practitioners are legitimated as types of knowledge – artists, too, create a type of knowledge.

Do the categories of art and science form a natural or even coherent split between materials or philosophies? It is hard to imagine so in the face of our ability to transpose the terms and descriptions of their contents and qualities. But it is certainly the case that a variety of people, from academics to laymen, tend to speak as if these two realms are cosmically separated. Are there examples we could call upon to undo this division? Is this a linguistic problem? An issue of historical moments? A problem of politics? In this Introduction I address some of these possibilities and describe a series of case studies that will illuminate the categories of art and science more fully.

My dissertation explores the relationship between the categories of art and science, told in three parts: the story of the glass scientific models created by a pair of German glass makers, Leonard Blaschka and his son Rudolf; the tactical media movement in the 1990s; and contemporary bioart as practiced at SymbioticA, a wet biological lab in Australia. These examples serve as sites to understand the significance of the categories art and science.

How the categories of art and science function, as well as how they are supported, materially and rhetorically, will become clear through my three case studies. I will avoid assuming that my central categories, art and science, are stable over time. Indeed it is their individual changes that I query. Nor do I assume that the components could change without also changing the relationship between art and science. Instead, I am interested in the categories the actors use when talking about art and science in context. The case studies reveal the degree of flexibility that objects possesses in terms of categories, as actors align resources around them. Considering the categories of art and science to be rhetorical devices can help us understand their fluidity and how an object can be labeled as art in one context and science in another.

Paradoxically, however, querying categories presents linguistic difficulties since it is necessary to invoke "art" and "science" in order to show how they are indistinguishable at times. A similar problem exists when deploying metaphors, like the "border" of art and science. When they are taken extremely literally it may confuse analysis. Metaphors abound for picturing this relationship, but I will try to avoid confusing the metaphor with the relationship itself. It is worth noting that

while science studies is only beginning to take account of artists' works on science, some groups of artists are already intensely aware of science studies ideas and draw upon them in their works.

The boundary between art and science is constructed by actors for political reasons. When I assert that my actors use the categories of art and science for political aims, I have a broad definition of politics as power relations, in mind. Additionally, I will use the term political in two more specific ways. The first is the colloquial sense of politics. Another sense of political I will employ is Terry Eagleton's definition of aesthetics, which suggests that aesthetics is whatever is left out of the Enlightenment project (Eagleton 1990). In the case of the Blaschka models, the politics take the form of efforts to sell the models or to recruit funds for their maintenance. Under Eagleton's definition, the politics in the Blaschkas' work are those aesthetic qualities that are not necessary for the models success as scientific models, but which are nonetheless present in the models and are part of the reason for their acceptance. In the case of tactical media works, the politics are explicitly about critiquing state and corporate power. Bioartworks tend to focus on critiquing the stability, ethics, and power of science. I will conclude with some thoughts about how the political and the aesthetic are intertwined.

By investigating the ways actors have used the categories of art and science, this work complicates the division between the two realms. It will involve being reflexive with regard to the categories people use to make sense of things, as well as the value and power-orientation assigned to those categories. For example, in the case of the Blaschka glass models, I will ask about the curatorial choice to display

the models at Cornell University in both an art and a science venue and how the definitions of art or science are changed by what is displayed as counting as one or the other.

I have separated practices into two categories: the rhetorical and the material. While these are not meant to be comprehensive categories, they give us a convenient division between times when materiality is central and occasions when the way people talk and write about their work comes to the fore. We may imagine that either rhetoric or material would experience a loss of force without the other, but it is the way that these two elements are more than the sum of their parts which will concern me here.

While it is possible to argue that materiality is only a resource for rhetoric, I contend that materiality as a separate category, one that is sometimes deployed rhetorically. Materials are vital in life worlds of the actors in this dissertation, and we gain a great deal by keeping them in a separate category, since it allows us to think about how the material, as well as the rhetorical, shapes category status as art or science. Materiality can serve as a way of talking, signaling, or displaying—in short creating— the difference in the communities of art and science. Their respective institutions help to provide networks capable of imbuing objects with network-specific meanings. The material can produce rhetorical effects by the way it is fashioned and positioned. To make the value of the material in relation to the rhetorical clear, I will pay attention to the mixture of the rhetorical and material in constructing categories. There are material ways in which rhetorical constructions are supported when actors are making claims, based, for example, on the

presentation of the self through clothing choices (Goffman 1959). Changes in rhetoric and materiality signal shifts in the art/science divide.

Science Studies of Art

In this dissertation I apply science studies tools to examples of artistic practice which invoke science as a source of ideas and technology, thus offering new ways of thinking about people and objects that have often fallen outside the scope of science studies research. While there has been substantive science studies scholarship on visualization and the use of images in scientific inquiry (Fan 2004; Jones, Galison and Slaton 1998; Hacking 1983; Dumit 2004), the realm of art has generally been considered interesting only as it may help to form scientific images. As my case studies show, art communities can be usefully analyzed using science studies tools. But, while there is a great deal of work on the intersections of art and science, so much so that it cannot be adequately covered here, much of it rests on assumptions that do not function alongside science studies work, and, thus, it does not serve the purposes of this dissertation. However, in a climate of limited art-science intersection texts, I have gleaned some valuable insights even from works that do not immediately connect with my case studies.

For example, Martin Kemp, an art historian and Leonardo da Vinci expert, argues that there are structures behind the natural world which manifest themselves in different ways in art and science (2006). Kemp calls these "structural intuitions," and they include both basic life processes and geometric patterning. His ideas seem in line with how he describes his primary research interest in da Vinci, as a seeker of the "universal." This may seem naïve to many science studies scholars,

but his motives are appealing. Kemp seems to want to make sense of the potential comparisons between art and science and approaches this goal through an interest in the content of science and art images. Rather than approaching the similarities as something created by the cultures of the two groups, Kemp sees the similarities as produced by interactions within the same world (2000). While this symmetry is admirable, Kemp assumes that the similarities are derived not from interactions with social structures but from the natural world, which he believes informs both scientists and artists. Kemp has also emphasized the use that Renaissance artists made of ideas about optics and seeing, ideas now associated with science (1990).

Samuel Edgerton also worked on the Reniassance investigating lineral perspective as it informed both art and science in that period (1975). This impression of the two worlds' similarities is an important departure from work like E.H. Gombrich's *Art and Illusion* (1960), which starts with the assumption that different cultures depict and see the world differently. In short, in Gombrich's analysis (1960), rather than starting from an observed object, art starts from a culturally embedded idea. Gombrich's idea that visual depictions are based not only on optical stimuli but on ideas about the world has a parallel in the science studies concept of theory-dependent observation. In other words, scientists' trained ways of seeing alter what they are able to observe (Kuhn 1970).

My analysis draws on a variety of theoretical works. My thinking on this subject would be impossible without Bruno Latour's *Science in Action* and Thomas Kuhn's *Structure of Scientific Revolutions*, both of which offer the opportunity to

reconceptualize areas of knowledge as the interactions between people and the objects they create.

For ideas about how sociologists view the artworld and how to study what artists and art movements have claimed as their history, I have enrolled Howard Becker as an influence (Becker 1982). Sociological ideas about identity also have been important for this study since such ideas are sometimes employed as tactical media tools. Following Steve Hilgartner's *Science on Stage* (2000), Erving Goffman's (1959) idea of performance to explain the similarities between the usual presentation of self and the presentation of a fictional self helps to e3xpolain both the positioning of actors in this dissertation as artists or scientists and, in the tactical media chapter, the more complex characters the actors create through their projects.

Science studies has intermittently engaged with art. Edgerton's (1975) first book on Renaissance art and science was published in 1976; Alpers (1983) raised questions about the legitmation of images through pictorial or textual means. Despite these important exceptions, in science studies it has been generally thought that while artists might draw on scientific tools, play on scientific themes, or be employed to praise scientific discoveries, the relationship was parasitic: artists followed scientists. A large number of contemporary artworks are re-contextualized scientific images (Frankel and Whitesides 2009; Frankel and Whitesides 2008; ImagineNano 2011; Resonance Fine Art 2011; Bell 2006). These moments of images moving from microbiology, astronomy, nanoscience, and many other scientific fields into art ironically may serve to reinforce the boundary. The science ready-mades

tend to privilege scientific imagery in its own terms, by insisting on the "naturalness" of the image and the ability of scientists to produce art-museum-ready works.

Becker's classic sociological work *Art Worlds* (1982) studied art as a community, in ways similar to how science studies scholars often approach science worlds. Becker relied on numerous examples to make the case that creation of art is always a joint activity, not work done solely by the artist but produced by the interaction of suppliers, dealers, critics, and consumers. Becker's theory undermined earlier ideas about artists as lone geniuses and demonstrated that we should understand art as communal. It is interesting that science studies scholars have made the same observation, thus amending the traditional view of scientists working alone to produce new knowledge. Becker noted that art communities come in various forms. He posited that these communities are held together by a belief in art, another claim that sounds rather familiar from examinations of the variety and differences among different branches of the scientific community. While the art communities I study generally do not believe in the myth of the lone creative genius, Becker's emphasis on the social aspects of art so resembles the way science studies scholars have approached science communities as to raise questions about what similarities and differences these communities create and maintain, and further, if we can trust their self-imposed system of categories.

Other scholars have been more interested in the crossover of theories from science to art and the anticipation of new ideas from science in art. Barbara Marie Stafford (2007) has argued that image-makers should seize upon the discoveries of neurobiologists to better understand cultural objects. More recently, she has written

on potential exchanges between the humanities and neurobiology (Stafford 2011). While many of her recommendations follow older assumptions about art making use of scientific discoveries, Stafford does see room for science to benefit from new ideas in art (1993).

Other scholars, like Katherine Hayles, have been interested in the impact that digital technologies and art/the humanities have on one another (1999). Hayles has also written on the convergence of the humanities and other new sciences, including chaos theory and nanotechnology (1991). Meanwhile books like Edward Tufte's *The Visual Display of Quantitative Information* (1983) take seriously the possibilities for improving understanding of technical images through changes in aesthetics that use art to improve science.

More central to current ideas about what science studies can offer discussions about art and science is Jones and Galison's (1998) collection of articles, which brought together a variety of scholars, including Latour, Haraway, Alpers, and Crary, to analyze the fields of inquiry which exist between the history of science and the history of art. The book demonstrated the incredible variety of examples that involve both scientific and aesthetic questions, as well as insisting on similarities between the two communities in terms of "knowledge-making," "image-making," and "object-making." By building on the conception of art as a knowledge-making community and on the value of this type of inquiry for asking new questions, we can draw on new aspects of older science studies subjects. In moments when the boundary between art and science becomes more permeable, it is easier to see that

the established definitions are simply being reproduced when science and art achievements are catalogued (Jones and Galison 1998).

Pamela Smith's *The Body of the Artisan* (2004) offered a historical account of the convergence of two previously separated modes: the making of things and the making of knowledge. Smith showed how science came to connect these two conceptions of the world in the early 17th century. Smith's argument, when she questions what counts as a scientific and what counts as an artistic endeavor, can be thought of as a moment of reopening.. Her investigation has made possible the idea that these seemingly closed definitions can be reconfigured.

Michael Lynch and Samuel Edgerton's (1988) study of the importance of aesthetics in contemporary astronomy revealed the way scientists talked about image manipulation, in particular, avoidance of language that involved aesthetic choices, as an important factor in how they understood what they were doing. Though their actions were in essence the same as those of visual artists—modifying the images—their rationales for doing so were different. The astronomers that Lynch and Edgerton studied claimed aesthetic choices only in cases where they were creating "pretty pictures" (1988, 191), and described similar actions on data as making the phenomena they were interested in more visible (1988, 194). This study was ground breaking in that it turned away from asking how art is parasitic upon science and intead inquired about the use to which scientists put their conceptions of art.

Sian Ede (2005), too, suggests that art concepts can be as useful in science as in art. She also notes that now scientists talk about "the beautiful" more than artists

do. This point is also echoed in art historian James Elkins' attempt (1999) at consilience with Galison's *Image and Logic* (1997). Elkins has made several attempts to bring art history into conversation with science studies works on images, or what he calls representations, for the sake of creating a shared language for art history and science studies (1995). Elkins hopes this shared language will allow art hsitorians to expand their vision of relevant iamges and science studies schoalrs to take a more nuanced view of images in their work. As a pioneer in the burgeoning studies of the visual, Elkins has been interested in focusing the tools of art history on non-art, including scientific and technological images. His engagement with science studies demonstrates that tools from both science studies and art studies can be brought to bear on the study of science and art and for recognizing the potential overlaps that already exist between the fields.

When we talk about art and science, we use a variety of metaphors. I propose that the best way to think about art and science in a science studies context is to treat art symmetrically with science. Science studies sees science as a network of people and objects with complex practices and varied goals, and we should see art in the same way. If these two categories are seen as separate pathways of thought or exclusionary angles on a subject, it can be very hard indeed to imagine that they could overlap. By understanding art and science as groups of people and things, it is easier to see how each may borrow from the other, so that individuals may participate in both at once without violating philosophies or principles.

Of particular relevance to my case studies of tactical media and bioart is a 2008 text by tactical media practitioner Beatriz da Costa and science studies scholar

Kavita Phillips. Bringing together scholars and artists, da Costa and Phillips put together a book that explores how contemporary art engages biopolitics. The text has the advantage of mixing the voices of scholars and artist-activists. It is useful for encouraging the variety and sophistication of artists' critiques of science and technology (da Costa and Phillips 2008). Another volume of collected essays which presents even more artworks and touches on some science studies themes is Stephen Wilson's *Art + Science Now* (2010). The book groups artworks by the science they use or critique and covers a variety of science-engaged artworks from robotics to nanoart (Wilson 2010). Far narrower and more specific is Anker and Nelkin's text (2004), which deals with art that stems from the questions and images around what the authors call "the genetic age." The book discusses some artistic responses to the coming of age and futures of genetics. As SymbioticA artist Oron Catts notes, it also includes some artists, like himself, who do not work with genetics or consider their artworks to be a response to the genetic age (Zurr and Catts 2005).

It is interesting that artists themselves have written such a variety of books on this subject. The fact that these books are not simply artist statements but, indeed, are attempts to grapple with specific issues in their own works and the works of related artists suggests that the artists themselves feel their work is under theorized. As one SymbioticA student told me, bioartists are forced to spend a lot of time explaining their work or including theory directly in the work. This may be a positioning move in which the artists are announcing themselves as misunderstood, but it could be that art criticism lacks the tools to deal with the technical and

science-critical aspects of many of these artworks. I hope to show that these tools are something science studies already possesses.

Daston's *Things That Talk* (2004) is an excellent model for the case study orientation of this dissertation. The contributors to the book each analyze an object and consider its place in art and science. Daston's chapter actually deals with The Glass Flowers at Harvard, whose counterparts, the glass marine models, are my focus in Chapter 1. Daston and Galison's *Objectivity* (2008) is an expansion of their article on the nature of objectivity (1992). In the book they provide a series of examples that historicize the concept of objectivity. They also briefly examine its counterpart, subjectivity. Daston and Galison's analysis accounts for changes in what constitutes objectivity, and emphasizes three main ways of thinking about objectivity: trained judgment, mechanical objectivity, and truth-to-nature. Their historicizing of objectivity implicitly offers the same critique of subjectivity. By undermining the idea that objectivity and subjectivity are stable categories, Daston and Galison effectively complicate one standard line of argument for the separation of art and science knowledge on the basis of associating subjectivity with art and objectivity with science. By deconstructing the possibility that the art-science divide is one of subjectivity-objectivity, the authors make possible a more nuanced view of these categories (Daston and Galison 2007).

Other examples of art and science studies coming together have occurred closer to the art world. The images produced from the 2007 Modern Museum of Art show "Design in the Elastic Mind" were appropriated as illustrations by the science studies journal *Issues in Science and Technology* (Antonelli et al. 2008). Bruno Latour

has been directly involvement with the art community. Latour, along with Peter Weibel, curated an art show and created the related publication, *Iconoclash* (2002). The show was held at the Center for New Art and Media (ZKM) in Karlsruhe, Germany, and dealt with the destruction of a range of icons from religion representations to those contemporary cultures. These collaborations demonstrate the science studies interest in and potential overlap with the study of art. With a sense of the scope of the available literature, it is possible to consider how my case studies may be approached.

Through this dissertation, science studies gains another area of study, art. This enables thinking about how knowledge is arranged, divided, and brought together into the categories of art and science. I will consider how artworks that take science as a subject or source of technical knowledge may gain from a more sophisticated contextualization. This will offer science studies as a lens for viewing certain kinds of heretofore considered being "art" works, thereby expanding the realm in which science studies tools may be employed. It also asks us, however, to stretch typical definitions of knowledge production to include forms of knowledge we have not always included. I shall show what it means to use science studies to study practices that straddle art and science and analyze how the categories of both art and science are made more or less flexible through actors' specific uses of the terms. Bioartists, for example, have varying views about the use of the term bioart. Some regularly employ the term because they believe it accurately describes their fusion of art and biology, while others object, believing that their attempts to

position themselves as artists who are critiquing biology is lost in the portmanteau quality of "bioart."

Treating art and science symmetrically in the science studies sense means that I will be agnostic about their claims to particular knowledges (Bloor 1976). I will not assume that it is possible to evaluate science and art knowledge in relation to one another. Instead I will direct my interest toward sorting out their practices and networks, in order to comment on their relationship rather than to assess their value. This requires a focus on materials and the ways people weave together ideas to represent actors' realities and to signal their membership in the networks of art or science. In addition, I examine how these collections of people, objects, and stories create the categories themselves. Attention will be paid to the way actors talk about these categories. To this end, I will discuss art and science as groupings of people and resources bound together by practices and stories. The relationship of science and art does not encompass everything, but considering these categories together does give rise to these two categories, a sense of the categories we have naturalized as different intellectual pursuits, and a productive place for thinking about what science studies tools can address.

For example, science studies is very good at examining change in the way people understand objects: from work on the circulation of immutable mobiles (Latour, 1987) to the concept of interpretive flexibility (Pinch & Bijker, 1984), science studies has found new ways to think about materiality. It is important not to fall into thinking that the materiality of objects is stable. For example, the glass models created by the Blaschkas are materially different today in their various

display and storage contexts than they were originally. Not only have restoration projects changed them materially, the types of organization and display have changed from attempts to illustrate the variety of species to presentations meant to attract attention for conservation causes. Similarly, materiality issues are complicated by the short lives of bioartworks, which after a few weeks' installation are only available online. It is somewhat ironic that this art, which concentrates on issues about living things, can only be studied later online. This change in materiality alters how the projects can be understood since many bioartists maintain that contact with the living subject is crucial to their artworks, yet most people experience these artworks via digital documentation.

While objects may help us think, they also help us argue; one reason for employing materials is that they make effective arguments. Science studies scholarship has shown that technologies may precede the scientific understanding of an idea or be co-produced with it (Latour and Woolgar 1979). Similarly artists use their works both to formalize ideas and to argue for particular worldviews. To provide some organization to the many ways the art-science delineation is created, I separate arguments made through objects from rhetorical strategies. Rhetoric may of course employ the ideas connected to materials, but this is different from employing the material itself as proof. Rhetoric may shape context and the meaning of a material, but I will separate this from working directly with materials. This labeling scheme will make it possible to think about the resources people employ—stories and materials—in making their arguments for what counts as art and what counts as science.

Approaches

My analysis has roots in science studies and critical theory. These sometimes overlapping systems of theory legitimate acts of questioning, by creating space for suspicion around "known" categories. As an act of questioning, my research requires not taking for granted the separateness of art and science. I show that science and art when treated as categories have interesting things to tell us about the ways we construct differences in types of knowledge. The research is both speculative and analytical, asking about practices and projecting possibilities for the meanings of art and science in different contexts. Rather than portray a moment of divergence or border building between science and art (Gieryn 1983) or relate to art and science through a concept like objectivity (Daston and Galison 2007), I will pursue specific cases that complicate our conceptions of art and science. Potential cases that bring together art and science are so numerous, that the reader will surely wonder why these particular cases were chosen.

These case studies have been chosen in order to question what is at stake in these categories; it is still perfectly plausible to imagine an individual creating something that is neither science nor art. The work done to produce the categories includes the deployment of rhetorical strategies by experts and critics, in addition to the artists and scientists. Together they produce an apparatus for categorizing objects, people, and stories so powerful that the system acts on both the knowledgeable and the less knowledgeable within the categories, as well as on lay people and those participating in the work of the other network. The art-science boundary can be contested, and this possibility necessitates the deployment of a

variety of boundary-work tools to maintain a bright line. For many of the actors in my case studies, the boundary is a chasm created to be overcome by those who are able to make use of the knowledge produced by one network in the other.

In addition, the case studies that make up this dissertation are connected in a number of ways. They all make use of aesthetics in Terry Eagleton's sense (1990, 8): "a bourgeois concept in the most literal historical sense, hatched and nurtured in the Enlightenment." Eagleton goes on to explain that this is not a reason to dismiss the idea but rather a reason to establish its history and query it. For Eagleton, aesthetics are always political and connected to what is omitted from knowledge creation processes. I examine aesthetics as a form of rhetorical posturing and take note of the different ways aesthetics, politics, and knowledge making are configured in each case. I will distinguish between aesthetics, in Eagleton's sense, and style, by which I will mean the formal and material elements of the works covered in this dissertation.

My initial approach to this material was to try to see examples of transitions around objects; that is, to observe an object moving from being an art object to being a science object or vice versa. However, this was not what I observed when I scrutinized my chosen examples. Instead, it seemed that both the art and the science character of these examples were always present. Different emphasis was placed on different elements at different times, and new contexts were brought to bear which changed the way the objects could be read. We sometimes speak of art, like science, as a monolith; it is no such thing. I found instead the variety of meanings in art and in science complicated even the idea of a transition. There is not a single transition or traceable change in how the objects fit the many definitions of art and science.

Instead these two categories are constantly in flux, with the potential to be employed by actors for specific purposes around the objects. For example, during my interviews with tactical media practitioners, some stated that calling their work art or science was irrelevant. All that mattered to them was that people were exposed to their ideas.

The science and art of a historical moment are intertwined, each effecting the other. It is impossible to imagine SymbioticA's tissue culture works outside the context of ethics and biotechnology of the present day, and it is equally impossible to imagine 19th century natural history without? the vital representations of artists, like the models made by the Blaschkas, which were integral to the scientific studies of that day. My three case studies show the interactions of particular moments in history of science with contemporaneous moments in history of art.

The difference between art and science is often naturalized as a set of opposite axioms (relies on history, divorces itself from history; objective, subjective) purported in some accounts to be stable. My argument requires considering the applications of art and science in context. By closely considering how these definitions are used in each of my case studies, it is possible to denaturalize them and create suspicion around what has been identified as a natural division. Through case study analysis, the categories of art and science can be shown to be produced by the discourse and material work of those who want to position themselves in the respective networks. Though artists and scientists may not feel that they are working to posit themselves particularly in relation to the "other" network, they are continually aware of boundaries of science/nonscience and art/nonart.

The division of art and science is reinforced by the signs of each community: ways of talking about their work and seeing their work in terms of other groups' work. Swiss linguist Ferdinand de Saussure's (1857-1913) response to the everyday notion of language as nomenclature applies here (Thibault 1997). For Saussure, language is not simply providing the ability to name pre-existing categories: it creates categories for thinking, rather than standing in for things in the world (Hacking 1998). By thinking that language describes predetermined categories, non-linguists "repress the reciprocal determination of values in the language system which arises from their very co-existence" (Saussure 50). Like bifurcated gender labeling, where only two available designations are commonly assigned to everything from language to objects, objects are assigned either art or science valence. Similarly objects, people, and even certain ways of framing stories are described as either art or science.

There are many ways this project might have been pursued. A philosophical approach might have attempted to differentiate between the types of reasoning used in art and science and analyze the internal logic of each pursuit. We could envision a project that would insist simply on selecting different projects to show that the realms of art and science are, in fact, separate matters. Indeed my case study selection initially rested on border objects, people, and practices. Rather than attempting to explain differences, however, I reason from similarities. Some of these objects were created to confuse the subject of categories and all are fed from their ability to connect separate communities in a way that at least one community sees as productive. Though some of the Blaschka models are on display in an art museum,

the models were originally created for scientific purposes. Conversely, when scientist Tom Eisner described why the models should be preserved, he mentioned their beauty. In the case of a project like Fish and Chips, which uses fish neurons and a robotic arm to draw images, part of what makes the project captivating for artistic audiences is that the results are used in the neurology community. Part of the value of these models for both the art and science communities extends from their perceived value to the other community.

This way of categorizing art and science into separate boxes is not only an issue in conventional parlance, but even among some actors working to create a borderland between art and science. Some bioartists, for example, often distinguish between their employment of scientific ideas and techniques and "doing science." They claim the former as their work and reject the latter, labeling the outcome of their work "art." Similar to the issue of rejecting the term bioart because it blurs together art and biology, the slipperiness of the terms art and science undercuts the definitions of what counts as science and at the same time attempts to reinforce the shield that makes artistic practice a thing unto itself.

In *Sorting Things Out* (1999), Leigh Star and Geoffrey Bowker explain the power wielded by systems of classification. Classification makes possible but also removes certain meanings from circulation (Bowker and Star 1999). In the case of art and science, this has involved making those designations more exclusive. When something is labeled as science it becomes more difficult to see in it the qualities of art, or vice versa. Those additional meanings are to some degree removed from circulation by the presence of the classification. How the elements of the art and

science categories are classified influence and sometimes constrain possible uses in the other category. As we will see in the case of bioarts, sometimes the tint of power left by the object's association with science is precisely what the artists are working with in their pieces. For example, the use by bioartists of tissue culture techniques that require specialized equipment like bioreactors to be installed in the gallery space draws attention to the fragility and potential preciousness of the life being housed in it, while creating room to redirect the scientific machine's power for the artist's purposes.

The availability of these two handy classifications causes some people to see the split as applicable everywhere, and yet either label defers the thing itself. Like "hands" being used to describe workers or "the crown" standing for the Queen, elements from either network can come to stand in for the whole. References to the Mona Lisa and microscopes conjure many adjacent ideas when they are mapped as fitting exclusively into the categories of "art" and "science." These stabilized clusters make it possible for bioartists to use white coats to signal scientific power without needing to establish a connection between lab coats and themselves or their work. Similarly, simply hanging scientific images in an art gallery without changing the image from what would be seen in a scientific article can cause the image to be re-read and produce entirely different meanings. The categories defy easy definitions which do not capture the muddy or continuous boundaries. Instead art and science are representationally understood through signs or example objects (white coats, gallery space) meant to explain the whole: synecdoche substituting for the indefinable.

The history of an object does not necessarily fall away even as new meanings are added. Art or science objects often remain to be played upon in new configurations of rhetorical and material practice. Some contemporary artists do this consciously, but I would argue that for most thinkers there is a constant, if unconscious, mixing of the material and the rhetorical in support of their claims and arguments. Many of these projects leave the question of the distinction between art and science unresolved by simply raising the mixing of science and art inflected rhetoric and materials without considering the reasons for the muddled distinction.

Signs, stories, and things are created to signal another, in this case the respective categories of art and science, which do not exist without the stories and things that make them up. Derrida's life of signs applies here: "through a series of supplements, there emerges a law: that of an endless linked series, ineluctably multiplying the supplementary mediations that produce a sense of the thing they defer: the impression of the thing itself…" (Culler 1982; 15). This categorization is not, however, "simply" a matter of language or of ways of talking about professional identities which enable understanding. Materials are also employed, and these objects provide the means for observing the naturalization of the categories. We may close our eyes and think that categories are made by language, but upon opening them we will have to work to see material objects in a new way, since they have been crafted to confirm our current conceptions of art and science. Our objections to the concept that language determines what we can think finds good evidence in the importance of materiality and the value of thinking with objects.

Understanding the relationship that is being configured, either through documents that explain a story of ideas and objects or by encountering the object itself, requires a type of attention that matches the story being told (Latour 2005). The attention commanded by art versus science has been crafted differently by different sets of actors. For example, we understand that a newspaper demands a different attention than a poem, but both require some of the same skills to read. Like art theorists considering what "art" consists of and science studies scholars asking questions about the definition of "science," we might consider the possibility that art and science are best thought of as particular types of attention, rather than features that mark them as one or the other.

The ideas and information we extract from a sculpture or chart depends both on our identification of the object as belonging to one network or the other and on our trained interpretive power. In this latter sense, questions about the identity of people and objects are brought forward. Understanding an object or person in terms of the art or science network positions the object of analysis for comparing and contrasting to others of its type. Reflection on the type of attention we are offering based on our identification of the relevant network can reveal both our ideas about what the category involves and the relationship we perceive between form and content.

For example, the idea of an experiment can tell us about the practice of science at large (Latour and Woolgar 1979; Pinch and Bjiker 1984). Experimental practice brings together form and content. In the case studies presented here, the way these objects are forged and presented expresses something about what it is

like to work in the borderlands of art and science and about the logics and norms of each pursuit. At the same time, stories, people, and things are also the thing (art or science) itself. Although not directly employing either the social construction of technology (SCOT) or actor-network theory (ANT) methods, I emphasize the networks in which my actors participate, as well as the social movements that coalesce around objects and reframe their meanings. For example, tactical media practitioner Paul Vanouse reframes the idea of DNA fingerprinting using his "Latent Figure Protocol." The title of the project is a riff on the "latent fingerprints" which, although invisible, can, through crime lab techniques be made visible culprit but Vanouse is investigating another metaphor, that of DNA fingerprinting. For his project, Vanouse uses the same scientific equipment – gel electrophoresis – used to prove guilt in suspects to make a very different point in its new framing. His demonstration shows that by working out the lengths of strands cut by known enzymes, he can produce a skull and cross bones or copyright symbol in the gel tray. This pictorial use of the gels has the potential to undermine our confidence in the absoluteness of DNA fingerprinting. The copyright symbol in particular suggests a suspicion around the commercial use of this technique. The use of the technology in Vanouse's project successfully detracts from the absoluteness or expected objectivity we have for a technology that claims to sort the guilty from the innocent. Vanouse's work would make little sense, however, without social groups who use, support, reject, and critique the technology's use in criminal investigations (Lynch and Cole 2005). The demonstration relies on the audience's familiarity with at least some of the stakes of the technology for some relevant social groups. The piece also

operates in part as a performance since Vanouse displays both the already run gels, videos of the gels, and, on specific occasions like art openings, gives a short lectures about the piece, explaining both the science and some of the implications of the piece for DNA fingerprinting and taking questions from viewers.

Similarly, the case of the Blaschkas might on the surface appear to be what has often been treated in science studies as a typical hegemonic relationship in science: glass artisans serving up their craft for use by scientists. But upon further inspection, we find that the Blaschkas contributed to science with their models and that their story reveals an effect of aesthetics in science. The reuse and preservation of these models in art and science contexts shows that the social moves objects around and that their display can transform their meaning to viewers. Furthermore, the power of the objects in the art or science context may derive from power ascribed to the object from the other context. The tactical media movement of the 1990s was a movement in which artists employed technology to create a political critique, and indeed, the actors emphasize that politics are at stake in their work. At another level, however, there is an implicit critique of technology's power and ability to be subverted for precisely the types of political maneuvers these actors regard as necessary to their practice. The bioarts movement displays actors who call themselves artists yet use the techniques and protocols of scientists. Their work uses and critiques science and yet they insist that their work is art.

A combined space that employs the labels of art and science without dealing with practices and people has been the focus of much theorizing in the fields of art criticism and philosophy of science. It is incorrect, however, to reduce art and

science either ideas or practices. Neither objective properties nor the consequences of framing seem likely to offer a complete picture of either realm. This dissertation will reconnect these ideas with the practices of people in order to clarify the relationship between the ideas of art and science and the people and practices involved in each category.

Methods

In order to focus these approaches on specific cases, I have used a mixture of methods including archival research, interviews, participant-observer techniques, and ethnography. A mixture of methods drawn from science studies has been appropriate in different proportions to my case studies. For the glass marine animals, archival research was fundamental; however, few paper archives exist for new media projects like those taken on by tactical media practitioners. Thus, the tactical media chapter was dependent on internet archives that catalog older websites, such as "The Wayback Machine." Face-to-face interviews were possible with people currently working on and curating the Blaschkas models, while Skype and list-servs were necessary for the tactical media work. For the bioart chapter, I was able to attend several museum installations, as well as conduct ethnographic research at a center of biological artwork research. Attendance at displays of all the works was important to putting together this dissertation.

The many interviews that were sources for this dissertation took a number of forms, but all used snowball methods to locate interviewees. My interviews with those involved with Cornell University's Blaschka model collection involved in-depth interviews with a small number of involved individuals. My interviews with

tactical media artists posed special issues, as they sometimes attempted to enroll me in their work by performing characters as I attempted to interview them. Because these artists are located in many places, many of these interviews were conducted remotely using Skype and traditional phone interviews. My interviews on location at SymbioticA made it possible for me to see and ask questions about many stages of the process of creating bioart. Each case required slightly different methods, so I will address specific methods concerns in each chapter.

I will consider three case studies. Each case investigates the material and rhetorical ways objects are shaped and accepted as art or as science and explores the question of how the categories of "art" and "science" work to circumscribe bodies of knowledge. The cases were chosen to demonstrate different aspects of the rhetorical and material resources that different groups of actors aligned in order to produce participation in art and science networks. Each example in the dissertation reveals the interplay between the categories of art and science. They were chosen after early probe research that suggested that these cases would bring forth complicated interplays between art and science.

The chapters happen to be in order by date, but they do not move chronologically or even in a point-to-point logic. They are meant instead to reveal the variety and complexity of actors' use of the categories of art and science. While these are certainly not special cases, neither do I want to suggest that we could take away a "general" lesson about how art and science categories interact. A cumulative effect in this sense is absent. Instead, through these case studies, I want to cast doubt on the idea that art and science can be thought of as stable categories,

showing how the method of accounting for material and rhetorical practices can reveal the construction of the categories of art and science in any other case we choose. If other case studies had been chosen, this dissertation would have likely identified different resources that actors use to position their work as art or as science, but I submit that the resources also could likely be divided into material and rhetorical resources. More important, I would speculate based on my findings here that even cases that might appear from the outside to have very simple art-science relationships, may upon closer examination, reveal the complex structure of these categories in relation to each other.

Chapter 1: Glass Marine Models. Leopold Blaschka (1822-1895) and his son Rudolf (1857-1939) created important scientific models made of glass for research institutions worldwide, including Europe, the United States, Japan, Australia, and India. The Blaschkas described themselves as "natural history artisans." They corresponded with imminent naturalist Ernest Haeckel (1834-1819), who loaned them scientific drawings and atlases, including some of his own work. Cornell University holds an extensive collection of more than 500 models that are divided between the University's biology and art collections. My research investigates the nature and logic of this division and the epistemological underpinnings of how art and biology groups have given the models meaning. In particular, this research exposes the way that Haeckel's aesthetics found its way into the Blaschkas' models and was accepted as the correct style for scientific models for many years. I analyze the way the Blaschkas and Cornell art and biology groups talked about the work as both art and science and the ways they positioned themselves and their models.

This chapter begins our look at art-science relations because on first glance it may appear to conform to previously held stereotypes about art: here the Blaschkas may seem at first simply to follow directions from the natural historians who bought their models. A closer examination of the case, however, suggests that the division of labor between artisan and scientist is not as clear cut as it might seem at first, and that the Blaschkas are operating independently from scientists and participating in the scientific community.

Chapter 2: Tactical Media. Tactical media is a genre of new media art that spans the borders between technology, science, politics, and art. This case focuses on RTMark, an art piece in the form of a website that rose to prominence during the early 1990s internet expansion. As corporations rushed to set up a web presence, RTMark came onto the internet scene, mimicking logos, slogans, and policy statements. RTMark's website declared that it offered "complex solutions for a simple world™" (RTMark) in order to deliver a stinging critique of corporate mentalities and the lack of liability law around the activities of corporate actors. Since these actors are engaged in shaping their projects from technical materials and situating them in an art or science context depending on their current needs, they are an excellent example of my central interest. When tactical media practitioners are making art, they are also making knowledge and waging politics. This chapter concentrates on the material and rhetorical resources tactical media practitioners enrolled to situate their work as either art or science in order to transfer their political message.

Chapter 3: Bioart. Bioart is a fusion of biology and art that ranges from drawing attention to the conditions of public understanding of science to critiques of specific technical procedures and the practice of science. Bioart includes both literal material critiques of science and more conceptual work; most work plays on both of these chords and provides the viewer with both a layer of intellectual engagement with the process and physical objects that encode a philosophy or propose a problem for consideration. For example, SymbioticA's "Victimless Leather" was a tissue culture project shown at the MoMA in 2008 at "Design and the Elastic Mind." It consisted of a tiny coat made of living cells seeded into a polymer matrix. The piece demonstrated the ethical and scientific ironies of a living garment, including its tiny size, which is all that can be achieved through current tissue culture techniques, and the fact that maintaining such a so-called victimless jacket, like all cells cultured in the laboratory setting, depends on the consistent use of a bovine serum that requires the deaths of many calves. The artists want to raise questions about the use of animals in scientific and artistic research and ask at what point the "sacrifice" of animals begins to offend ethical sensibilities. The piece also raised issues about the use of living systems in artwork. This constellation of issues, with emphasis on the last, has been collectively referred to by the artists as the "aesthetics of care," by which the artists mean what is required to support life, which includes both lab apparatus and the regular actions of researchers, like feeding (2002). The project drew the attention of the press when the cellular growth began to interfere with the tube used to deliver nutrients; subsequently feeding was discontinued, thereby killing the artwork. I analyze the ways we can understand

scientific practices and expertise employed by bioartists, and how they go about rhetorically and materially fitting their work into the categories art and science.

Contemporary art critiques, such as those embodied in tactical media and bioart projects, range from drawing attention to the corporate control of science to attacking specific scientific methods and ideas. The Blaschkas works were designed with a scientific audience in mind; their work contributed to conversations inside the scientific community. In this sense, we can divide these artists' involvement with the scientific community in ways that are similar to the demarcation of science studies critiques: as internalist or externalist. Bioartists, for example, offer a hybrid contribution: their works often require knowledge of laboratory protocols to fully appreciate the technical work, and yet the aims of their science ethics pieces are meant to reach broader audiences in the art community and general public.

At stake in these examples are questions about the power of one category over the other. One aspect of this issue is the right to participation in networks of art and science and the possibilities for subversion of categories to reveal questions about the right modes of contribution and critique. Who gets to participate in creating the categories of art and science, what does right participation mean, and how do these different purposes count? Ironically for the tactical media practitioners, sometimes in order to have the right to participation in scientific dialogue the project must submit to so many criteria for inclusion that no outcome outside of the orthodox scientific view is possible. In order to produce a new viewpoint, some of the scientific requirements must be disregarded.

Can a meaningful critique of a network originate from outside a knowledge network or is full participation—an agreement to all the rules—necessary to participate, even if this forecloses certain outcomes and possibilities? Is there anything to be added by allowing art and science to address each other or is the productivity of the comparison a matter of pointing out differences? I will return to these questions in the final chapter, but first we will turn our attention to the details of the cases themselves.

CHAPTER 2: BLASCHKA'S SCIENTIFIC MODELS:

AESTHETIC KNOWLEDGE

Introduction

This chapter concerns two glassmakers, Leopold Blaschka (1822-1895) and his son Rudolf (1857-1939), who created important scientific collections for research institutions worldwide, including in Europe, the United States, Japan, Australia, and India. The Blaschkas' glass models are an example of a class of objects that in some contexts are seen as art and in other contexts are seen as contributions to science. Importantly and perhaps counter intuitively, their value in the one arena (science or art) contributes to their acceptance in the other. The Blaschkas, though usually considered glass artisans, contributed materially to the scientific discourse, education, and research of their time. Our emphasis here will be on the way the Blaschkas and the curators of their work have fit the glass models into the worlds of science and art. As we shall see, the Blaschkas' aesthetic was instrumental for the acceptance of their objects as useful for scientific purposes, and the preservation of their models in the contemporary context is predicated in part on the continuing interest in the aesthetic qualities of the models.

The Blaschkas' work ranges from marine invertebrates (See Figure 2.1) to magnified models of microscopic organisms like radiolarian to the botanical specimens at Harvard, known as the Glass Flowers (Schultes, Davis and Burger 1992). The motto of the glass flowers at Harvard is "A marvel of art in science and a marvel of science in art" (President and Fellows of Harvard College 2011). The Glass Flowers, finished by Rudolph Blaschka after his father's death, are widely

considered the culmination of their skills and are a tourist destination on Harvard's campus. In 1951, poet Marianna Moore wrote of them: "Superior people never make long visits/have to be shown Longfellow's grave/or the glass flowers at Harvard." But surely the masses do have to be shown the Glass Flowers, as 180,000 visitors per year visit Harvard's Natural History collections and the glass flowers are one of the most popular exhibits (President and Fellows of Harvard College 2011). However quaint today's botanists may find the models, naturalists of the past praised them for their lifelike qualities and they continue to be revered for their "realistic" qualities (Daston 2004). What exactly produces the idea that the models have realistic qualities is an issue this chapter will return to later.

Figure 2.1. Cornell Blaschka Models (Left: *Acolis despecta*, Center: Jellyfish, Right: *Glaucus longicirrus*.) Images by William Warmus.

A first impulse might be that whoever made these objects must have worked under the direct tutelage of natural historians who had a sophisticated knowledge of sea creates, from the range of jellyfish to the microscopic. This, however, was not the case. The Blaschkas were independent businessmen who saw an opportunity to use their glass skills to make entry the scientific community.

The chapter begins with a brief history of the Blaschka models and moves on to a discussion of the display of the glass marine models at Cornell University. It then returns to the question of aesthetics and analyzes the function of style in terms of these models. Finally, it considers how these models have been enrolled in the networks of art and science at different times. Rather than understanding the scientific communities' interest in these objects as based simply on the "correctness" of the Blaschkas' representations, I shall argue that the acceptance of these representations rested in part on the style in which they were rendered. The aesthetic qualities of these objects at different times are not a side note to their importance, but are critical to the scientific interest in these objects. Aspects of style were resources martialed by actors to make the case for value of these objects in several different contexts.

As Chadevarian and Hopwood's (2004) collection of examples of models has shown, three-dimensional models were indispensable for science since they offered three dimensional representations without the color and form degradation of preserved specimens. By the 19th century many scientific models, ranging from medical models to botanical specimens, had been created by artisans working in wax (Alberti 2009) and papier mâché (Märker 2005). The Blaschkas were working in the tradition of creating scientific representations for study and pedagogical purposes (Dyer 2008).

Before the exclusive contract with Harvard's botanical division, the Blaschkas created glass models for sale through a variety of channels, including institutions in Europe, the United States, Australia, and Japan. In the United States, Ward's Natural

Science catalogue presented around 700 models for sale to institutes or individuals. The Blaschkas' first catalog described the models as "decorations for elegant rooms," but it soon became clear that naturalists and institutions would be the primary buyers of these models (Meechan and Carter 2011; Arwas, Newell and Gallery 1996).

As we shall see, Cornell University became such an institutional buyer. As of 2011, the Cornell collection is spread over four locations. There are three on-campus displays, plus a fourth site at the Corning Glass Museum in Corning, New York, where the remaining Cornell-owned models are in storage. While my analysis covers the Blaschkas' work as a whole, I have paid special attention to Cornell University's collection. The models on display in Corson-Mudd Hall and Mann Library have undergone restoration, while those at the Johnson art museum are largely one-piece models that did not require significant restoration. Around four hundred models, in various states of repair, are in storage at Corning await restoration and display.

The Blaschkas had long related their scientific modeling to artwork. In their first catalog, they advertised the models as both fit for the naturalists' purposes and as "decorations for elegant rooms" (Reling 2003). Though this language drops out in later catalogs, the Blaschkas continued to conceive of themselves in terms of inhabiting a combination of art and science worlds. In fact, the Blaschkas' family headstone at the cemetery in Dresden-Hosterwitz reads: "Scientific Glass-Artists" (Silbernagl 2011).

The Blaschkas' engagement with the scientific community is not unique. The story of artists engaging with scientists and creating knowledge, particularly visual

knowledge, is an old one—one that stretches back even before our current distinctions between artists and scientists. An excellent example is the many interminglings of these two pursuits in the study of nature. The naturalist has a variety of skills to observe and display nature. Pamela Smith's *The Body of the Artisan* helps account for the role of artists in relation to the new knowledge practices of science in the 16th and 17th centuries (P. Smith 2004). There is a long history of creating difference and links between the concepts of artist and artisian. Recent feminist scholarship (Gouma-Peterson and Matthews 1987, 326; Hagaman 1990, 27) has sought to revise art history to include what are sometimes known as "crafts," usually women's artisanal products. The Blaschkas are referred to by others as artists, but they referred to themselves as artisians. This may simply be a manner of speaking, but it also might have to do with the value they placed of being seen as craftsmen in an artisial culture.

In addition to the craftsman's skills necessary for representing and working with the new sciences, Lynch and Woolgar have revealed ways of seeing science's objects. Lynch shows how representation allows new ways of focusing on the scientific object (Lynch and Woolgar 1990, 153-186). One of the most comprehensive efforts to assert what science studies can add to investigations of art and science is *Picturing Science, Producing Art* (1998), by Caroline Jones, Peter Galison, and Amy Slaton. They provide a broad sampling of science studies-related work on art and science topics, with chapters by Bruno Latour, Svetlanna Alpers, Donna Haraway, and Londa Schiebinger, among others. Elsewhere, Londa Schiebinger's (1986) work on anatomy has shown how gender politics were part of

anatomical drawing, as well as how ideas about sex and marriage influenced Linnaeus' categorization of the plant world and Erasmus Darwin's depiction of a sex-based plant system in poetry (Schiebinger 1996).

Science studies scholar have shown that artists, in different forms, have been present with and a part of the project of natural phlosphy and history dating back to figures who are now consdiered Renissance men, like Leonardo and Durer. Nor have science studies scholars' interests been limited to European art-science relations. Fa-Ti Fan's *British Naturalists in Qing China: Science Empire and Cultural Encounter* (2004) shows how art, science, and colonialism came together to serve the naturalists' needs. Fan traces the history of colonialists in Qing China who were interested in sending home specimens and evidence about the animals, plants, and insects in China to be verified by the scientific community. These naturalists, who often lived in China for years, employed Chinese artists to create images for verification which were a distinctive mixture of the requirements of the colonist clients and the traditions of commercial art in China.

The Blaschka models might be thought of as immutable mobiles. The need for immutable mobiles (Latour's stabilized representations that allow science to "act at a distance) might be circulated to represent specimens not yet unavailable in Britain—serves to point out the role that artists have played not simply in creating the means for scientific ideas to be circulated, but in creating scientific knowledge directly (Latour 1987, 229). The Blaschkas' scientific models are similar to Chinese drawings in that the models encode scientific ideas, but they are more than a means of codifying known principles into a model object. These artists went beyond

copying scientific images or recording scientific points in a disciplined fashion. Instead, the glass models necessarily involved the presentation of all kinds of information not available in the scientific literature or existing images. In order to create three-dimensional, detailed representational objects, the Blaschkas had to do their own studies and observations, and in doing so they were creating new ways of knowing sea creatures that would otherwise have been represented by flaccid specimens in jars or two-dimensional drawings. The knowledge the Blaschkas created was a method of displaying the salient features of marine life to the satisfaction of the scientific community.

This chapter explores the ways in which the Blaschka models have been rhetorically and materially shaped by a variety of actors and institutions. At different times these models have been the tools of naturalists, pedagogical objects, scientific models, historical artifacts, and art pieces. They have moved in and out of favor according to the politics surrounding them and the ways in which they have been coded in different contexts. By tracing how these objects have been displayed and talked about at Cornell, this chapter will expose how objects like the glass marine models can be made to function as part of the networks of art or science.

Method

My study of the Blaschka glass models has relied on archival work and interviews. I have interviewed in person, by phone, and by e-mail scientists, artists, a glass restoration expert, amateurs interested in the Blaschkas and their work, journalists, glass scholars, and museum curators. Interviewees were selected based on their involvement in the Cornell display using a snowball method. I consulted

examined archives and records at the Johnson Museum of Art, the Cornell University Archives, and the Corning Museum of Glass's Rakow Library.

The Corning Museum of Glass in Corning, NY, maintains an archive of the Blaschkas' sketches and much of their correspondence, which was helpful for assessing the changes in the Blaschkas' drawing style and the relationship between other published works of the time and the drawings the Blaschkas made based on those publications. The Cornell University archives and image collection were useful for sorting the details of the acquisition of these models and their physical movement around the campus.

By lucky coincidence, during the course of my research the Mann Library collection opened at Cornell, and Drew Harvell, curator of Cornell's Blaschka glass models collection, gave a talk that helped me frame how scientists value the Blaschka collection today. Eveline Ferretti at Mann Library provided useful documents about the Mann collection and the way it has been advertised to increase interest in the exhibit.

My primary interview source was Thomas Eisner, the Cornell professor who discovered the Cornell Blaschka models after they had been neglected for some years. I interviewed William Warmus, a glass expert who has written about the Cornell Blaschka collection for *Glass* magazine. Warmus has studied and photographed the Cornell collection. I also interviewed Elizabeth Brill, the glass and marine expert who is working to restore the collection and who offered insights about her restoration techniques. Brill has worked and consulted on several other Blaschka model restoration projects.

At the Johnson Museum of Art, Associate Curator Andrew Weislogel provided that the museum's perspective as well as his own observations and helped me look for documentation relevant to the objects on loan, traced the path the objects followed into the Johnson Museum's possession, and assisted in securing important interviews with the Museum's registrar, Matthew Conway, and then-director, Frank Robinson. Images of the Cornell models are used with the permission of Drew Harvell, the curator of Cornell's Blaschka Glass Marine Invertebrate Collection.

The Blaschkas and the Natural History Tradition

The Blaschkas described themselves as "natural history artisans." Their work was very much an art act of their time. In order to represent, teach, and display difficult-to-preserve specimens, institutions undertook projects of taxidermy and the systematic collection of scientific drawings. As modern museums were established in the 19th century, they came to provide places for research and displays for the public, and the Blaschkas created objects that fit into such collections (Schultes, Davis and Burger 1992). The popular interest in the sea, and in particular a fascination with jellyfish and anemones, opened a space for them to provide a scientific tool that would enhance both their standard of living and their reputations. Natural history was popular in the Blaschkas' time and the father-son team obliged the moment with work that satisfied the demand for realistic models, as judged by the standards of the day. They navigated the networks of science while maintaining a claim to be glassworkers in the network of the traditional craft (Rossi-Wilcox, et al. 2007).

In the 1870s, Rudolf joined Leopold in creating models. Rudolf had studied anatomy, botany, and zoology at the Dresden Imperial Academy. As a consequence, whereas his father's training was oriented toward the family craft of glass and Rudolf worked with his father making floral jewelry, he had made some forays into the science of the day (Collins 2004, 192). The Blaschkas used the illustrations from Phillip Gosse's *A Naturalist's Rambles on the Devonshire Coast* (1854) and *Actinologia Britannica: A History of British Sea Anemones* (1860) as the basis for additional sketches and, eventually, glass models (Schultes, Davis and Burger 1992). Without direct access to some marine creatures, the pair studied the drawings as if they were the organisms themselves. They created drawings based on others drawings and then completed their models. The Blaschkas also corresponded with Ernst Haeckel (1834-1919), a leading marine naturalist and proponent of Darwin's theories. Haeckel sent the Blaschkas scientific drawings and atlases, including some of his own work.

Early in life, Leopold was prescribed a sea voyage for his health, and he travelled to the United States (Rossi-Wilcox 2008). Scholars often credit his study of sea life during the voyage as the starting point for his excitement about natural history (Rossi-Wilcox, et al. 2007). Also prominent in stories, and potentially connected to a point about the artisanal bloodlines that Leopold Blaschka wished to make, are references to the Blaschka family originating in Aicha, Northern Bohemia (now the Czech Republic), and relocating to Hosterwitz, Germany. Later in his career, Leopold Blaschka would claim that his family members were famous glass makers in Bohemia. Following the exhibit of Leopold's glass orchids arranged by

Prince Camille de Rohan, Ludwig Reichenbach in 1863, the director of the Dresden botanical gardens and natural history museum, took an interest in Leopold's work.

Reichenbach's connections and access to specimens proved important for the Blaschkas' work. The first zoological models to be shown were representations of the British sea anemones and corals. Reichenbach exhibited these in dry aquariums in the Dresden museum (Reiling 2003). This suggests that the Blaschkas were modeling to create objects that looked as if they were living. After their move to Hosterwitz, the Blaschkas' work became increasingly well-known, and they shipped models around the world (Rossi-Wilcox 2008; Rossi-Wilcox, et al. 2007; Rossi-Wilcox, Reiling and Bisaga 2003).

The Blaschkas practiced a distinctly 19th century style of scientific representation. From specimens they were sent and from the atlases and drawings of naturalists, they created preparatory drawings and then glass models. They, like many 19th century elites, kept an aquarium and eventually a large garden with many North American plants. They used their aquarium and exotic garden to create models for Harvard's botanical collection. Additionally, Rudolf took several fieldtrips. Despite his father's initial objections (Americans "eat too much ice" and "are all in a great hurry"), Rudolf travelled to the United States and the Caribbean (Rossi-Wilcox 2008). On these trips Rudolf created drawings that the pair could then render into glass.

Rudolf's trips and the guides and graduate students who accompanied him were arranged by Professor Goodale, the first director of Harvard University's Botanical Museum. Goodale later facilitated the formation of the Glass Flowers

collection through lobbying his colleagues, making arrangements with Mary L. Ware and her mother, the patrons of the collection, and providing specimens and images for the Blaschkas to use as a basis for their models. Goodale first came into contact with the Blaschkas' work in Harvard's Museum of Comparative Zoology, which had a set of the Blaschkas' glass marine invertebrates.

During Rudolf's 1895 trip to the United States, Leopold died. After his father's death, Rudolf continued to work by himself. When Rudolf retired from glass making in 1936, he was nearly 80 years old, and had created more than 3,000 models for the Harvard collection alone. Thousands more had been made for universities, museums, and naturalists worldwide.

Display at Cornell

Cornell University's glass model collection began with the interest of Professor Comstock of the Department of Entomology and Invertebrate Zoology and A.D. White, the university's co-founder and first president. In 1882, White commissioned a set of marine invertebrates from Ward's Natural Science Establishment in Rochester, New York (Warmus 2001). Ward's carried a catalogue of the Blaschkas' models, which were each made to order, as the Blaschkas required payment for the models and shipping costs prior to beginning their fabrication (Dyer 2008). In the *Comstocks of Cornell* (1953) Anna Botsford Comstock writes: "[In] autumn [1882]…the President became enthusiastic over the beautiful models of invertebrates, made in glass....President White went with Mr. Comstock to Rochester to select and buy the glass models." It is interesting that Anna Comstock notes their aesthetic qualities, "beautiful models," as a reason for White's interest.

In all, over 700 models, covering a large range of marine species, were created for Cornell University. Of the original models, 570 have survived, although in recent years fewer than two hundred have been on display (Mann Library 2002). The models are made primarily of glass but some glass sections are put together with wire and glue. Some of the models are painted, while others are made from colored glass. The variation in materials that contract and expand with the temperature and humidity at different rates has caused some of the models to degrade (Brill 2010).

Soft-bodied sea organisms are difficult to preserve, and this was a particular concern for the Blashckas contemporaries. In particular, the form and colors of many marine animals were thought to be destroyed by preserving agents. I will return to the question of other possible materials for representation later in this chapter, but for the moment, it is enough to understand that, for their 19th century users, glass models offered a stable—albeit rather fragile—pedagogical tool to teach about both species differences and the anatomy of sea creatures (Dyer 2008; Albert R. Mann Library 2009a). The Blaschkas' models were trusted to stand in for organisms that the users might never have seen.

The Cornell models eventually ceased to be used for teaching and were placed in storage. In the fall of 1957 they were "rediscovered" by Professor Thomas Eisner and his graduate student, Roger Payne, in Roberts Hall (Warmus 2001). Eisner was beginning a career in the life sciences at Cornell which would span five decades and include the discovery of chemical signals exchanged between insects. According to Eisner, the Blaschka models were barely visible through the windows

of a wooden cabinet in the hallway of Roberts Hall. Eisner inquired about them but the key was lost. Using a paperclip, Payne managed to open the locked cabinet. Inside they found these "incredible" models (Eisner 2008).

It seems likely that the models initially joined the University collections; the records of the University collections are now held by the Johnson Art Museum, but as many items were grandfathered into the museum's registry of items, it is not possible to verify that the models were among those items. During the 1940s, it seems likely that the models made their way to the cases where Eisner found them in 1957 when the University collections were divided up among departments and new display collections (including the art museum, a mineral display, and an anthropological collection). It is worth noting the Johnson Art Museum was only completed in its current form in 1973. While the museum director recalled that the models were initially brought over on loan by Eisner, the next records are those for insurance in the early 1990s.

In interviews, Eisner was able to fill in many of the gaps in the records (Eisner 2008). Eisner was not aware that the models were made by the Blaschkas, although he knew about Harvard's botanical models. He was, however, so impressed with them that he began to investigate how they might be better preserved, as all were dusty and many were damaged. In 1964 when he published his first book, *Animal Adaptation* (with Allison Burnett), Eisner reproduced several photographs he had taken of the glass models to illustrate specific points about the lugworm, sabella, and squid. Unable to interest members of the science network at Cornell or the then Dean of Agriculture, Charles Palm, in the models, Eisner made contact with

the Corning Glass Museum. The museum staff identified the models as the Blaschkas' and were very keen to store them. Thus the models were relocated some two hours away in Corning, New York (Eisner 2008).

Dr. Elizabeth Brill, a marine biologist and glass restoration expert, has restored a number of the models that are on display at Cornell University in the building for Ecology and Evolutionary Biology (Corson-Mudd Hall) and the Albert R. Mann Library for agriculture and life sciences. Hoping to bring all the models back to campus, the current curator of the collection, Drew Harvell, a coral expert in the department of Ecology and Evolutionary Biology at Cornell, has been working to raise money for their restoration and display.

The collection at Cornell is currently divided among four sites, making a contrast between their art and science contexts. Most of Cornell's models are in storage at the Corning Glass Museum. The first place the models were shown on campus after their rediscovery was the Johnson Art Museum. The Museum had the resources to place a small group of objects on display. As funds became available, a larger display was added in Corson-Mudd Hall. On June 11, 2010, the Mann Library opened the third public display of the Cornell's Blaschka models with a lecture by Harvell.

On the surface it may seem odd to break up a collection that surely drew at least some of its power from comparative studies. This, however, is a story about how people work to align resources to keep the models in circulation. The need to find resources to preserve the models constrained decisions on where and how to display them. Considering where the models were displayed and how they were

defined as being important for art and for science is vital to understanding the models. The models had to be accepted as counting in the networks of art or science, and conversely, the science or art context framed how viewers see the objects. Several people had a hand in crafting definitions, a task that revolved around making available resources relevant to the models and vice versa. A division of the collections and reorganization around new principles in several different locations does raise questions, however, about what the models represent in their new contexts.

The Johnson Museum glass model collection is a selection of objects on loan from the primary collection, an arrangement that is renewed annually with the primary curator of the collection, Drew Harvell. While the particulars of the origin of the loan are unclear, Eisner was extensively involved with the University's art museum. For example, he donated an early photograph he made of an insect's eye-view of the target shapes insects see on flowers—shapes that are not visible to the human eye—and he helped the curators identify the insects that artist Otto Marseus van Shrieck included in his painting, "A Forest Floor still-life with Various Fungi, Thistles, an aspic Viper, a sand lizard, a snail, a tree Frog and two Moths." It is likely that Eisner's connections to the museum, both as a contributor and an information resource, facilitated the loan of a small group of Blaschka models to the museum.

The glass models are currently displayed on the second floor of the museum at the top of the stairs. They are surrounded by American paintings, including Andy Warhol's 1964 "Most Wanted Man No. 1 John M." and Lee Bontecou's 1959 "Flit."

The models are housed in a glass case the size and height of a desk, with a light background for the display surface.

Figure 2.2. Johnson Art Museum display case of Blaschka Glass Marine Models.

William Warmus, who has photographed Cornell's collection, has noted that he feels that a dark background would allow the models to be seen more clearly, but the light background is standard for the museum's display cases (Warmus 2001). Indeed, most of Warmus's photos offer a black or nearly black field on which we see the then more colorful model (see Figure 2.3).

The art museum's display of the models uses only the scientific labels still attached to the models and the related text describes them primirlay in terms of their historical and craft value. It has not been possible to learn what criteria were used to select models for loan to the Johnson Museum, but the absence of, for example, jellyfish with their delicate individual glass tentacles, suggests that the ability to move the models safely was considered. The models themselves are not

laid out in lines but placed around the case in a relative balance of sizes and forms. It is also worth noting that is appears that these models were moved to the art museum with minimal restoration, so part of the choice of which models appear there would surely have been which models were ready for display. Because the creatures that were pieced together with wire and animal glues were particularly fragile, it seems likely that those models would have required more restoration and, therefore not been available for immediate display.

Figure 2.3.Octopus from Cornell's Blaschka glass marine model collection. Photograph by William Warmus.

In the museum display only one of the original name cards on the specimens has been preserved. Relative to the rest of the collection, the individual pieces at the Johnson are, on the whole, smaller than those in either Corson-Mudd or Mann Library. The type of model on display is likely the result of concerns about moving the objects, but the effect is that the models appear rather more mundane than the

ones in the more theatrically dark backgrounds used in the science displays and in Warmus' photographs.

The bottom of the museum case is beige, and the accompanying text is written in a sparse factual style, describing the origins of these particular models, including their rediscovery by Professor Tom Eisner. The accompanying text celebrates the objects as being: "originally intended as models for biological studies, but [which] have now also become acknowledged as artistic productions." This way of talking about these objects in their art context is similar to the way that Curator Andrew Wieslogel discusses the museum's interest in the objects: part of the value of the objects to the art network stems from their value in the scientific context (Wieslogel 2010). The presentation of the objects in the Johnson Museum poses a stark contrast to attempts elsewhere to attract new audiences to science by displaying spectacular scientific works in art museums. The science evoked in the display is of historical importance to the University and the given the invocation of the Glass Flowers in the display captions, in popular culture and literature, beyond.

Figure 2.4. Johnson Art Museum display case and related text for the Blaschka Glass Marine Models.

The Johnson Museum's display can be usefully contrasted to the collection located in the atrium of Corson-Mudd Hall (the Ecology and Evolutionary Biology building), which is the largest display of Cornell's Blaschka models. The display is flanked by a salt-water coral aquarium and a collection of taxidermy birds. Cases of taxidermy on either side lend an air of the past, offering a sample of different ways science has approached the natural world. Also prominent is a display advertising the University's marine biology study abroad program, yet another way, besides aquariums, stuffed birds, and glass models, through which students might encounter the natural world.

Figure 2.5.Blaschka Model Cases. Corson-Mudd Atrium.

The Corson-Mudd models are displayed along with a detailed descriptive poster, including images of the Blaschkas' sketches. The three cases are pictured above (Figure 2.5). Two multi-shelved cases, which make it possible to view the models from different angles, flank a larger center case. However, the glass shelves in these cases mean that viewers can see right through some of the translucent models, making it hard to pick out details. The third, longer, case is in the center; it has a dark blue background that offers somewhat better viewing.

Since not all of the university's models have been restored, what we have on display are selections. In the left-hand case, taxonomically-related models are grouped together. The right-hand case has a backing meant to represent the ecosystem in which a given group of models belongs.

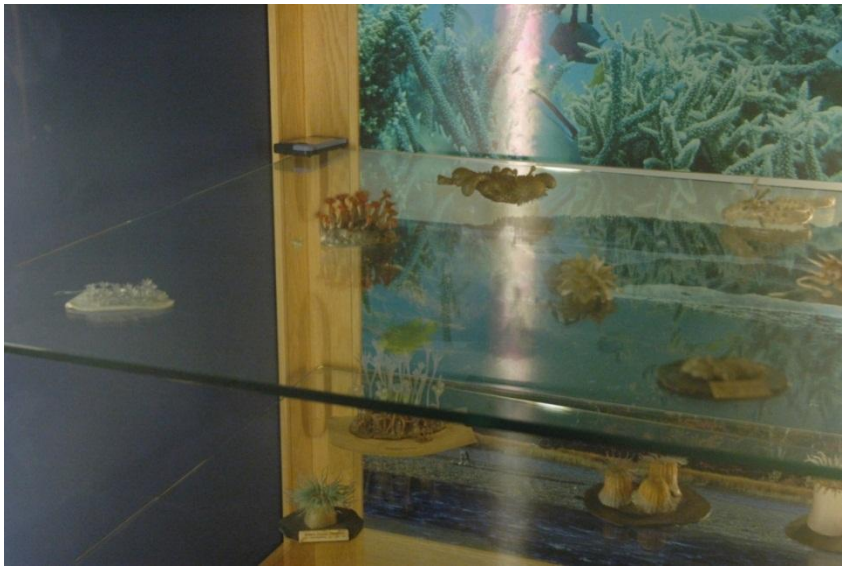

Figure 2.6. Blaschka Model Cases. Corson-Mudd Atrium. Right hand case.

Here, instead of being grouped by taxonomic relationship, the models are grouped in diorama style by the ecosystem in which they appear (Figure 2.6). The background consists of photographic laminates, which adhere much like an aquarium backing and suggest additional information about the ecosystem of the models.

The groupings in Corson-Mudd Atrium form a sharp contrast to the small display in the Johnson Museum. In Corson Hall, the models are meant to be viewed in groups: either by species type or shared ecology; the models have been enrolled to depict changes in methods for studying the natural world. The arrangement of these pieces is meant to emphasize the "correct" way to see the models, as learning tools that are both identifiable and distinguishable from one another. The result is a coding of the objects as valuable in terms of groupings of similar specimens and as species that share ecosystems.

Figure 2.7. Blaschka Model Cases. Corson-Mudd Atrium. Right Hand Case detail.

The Mann Library offers two further ways to experience the models: two cases located in the stacks of the library, and an online catalogue and explanation of the models. The two cases include a range of specimens, similar to those in Corson-Mudd Hall. Mann Library also has created two websites related to the Blaschkas, both of which offer background material about the Blaschkas, their influences, and their working techniques. One site gives a brief summary of the history of the models (http://exhibits.mannlib.cornell.edu/blaschka/). The other catalogs the models for easier sorting (http://blaschkagallery. mannlib.cornell.edu/today.php). The websites feature a complete list of all the models in storage and on display. The Mann Library online collection offers more historical information than the physical displays and explicitly frames the models as political objects. The appeal for the value of the models offered on the Mann Library website today (2011) is as much about conservation of the oceans as about conservation of the glass: “As earth's

oceans are degraded, as their numbers of endangered or threatened inhabitants grows, these 19th century teaching devices could conceivably furnish exquisitely rendered records of what has been lost for students of the 22nd century" (Albert R. Mann Library 2009b).

At the opening of the display, Curator Drew Harvell described the models as tools for future conservation research and repeatedly invoked their beauty (Harvell 2010). While it might be argued that, for naturalists, beauty can be taken as a scientific category, today we primarily associate invocations of beauty by scientists with an attempt to draw in the public. The value for Harvell seems to be in these objects' ability to reach new audiences and to be translated into a marine conservation interest. In short, their value is not simply in being scientific objects but in being beautiful objects with broader appeal. It is something beyond the scientific that makes them important. The extension of value by evoking criteria assumed to be outside the domain of science is the equivalent of the work done by the text in the Johnson art museum: the objects' values set in their respective networks are predicated upon their value in the adjacent network.

These three different displays are examples of the way specific actors involved in the networks of science and art have enrolled the Blaschkas' models for their own purposes. The art museum's display emphasizes the craft aspect of these pieces: they are celebrated in relation to their scientific roots and the craft techniques necessary to produce accurate models. The minimalist display case allows attention to fall on each individual object and its details. Viewers are perhaps meant to understand that art and its techniques penetrate even their presumed

opposite: science. The models are made different and their meanings potentially changed by their context. Where the art-contextualized models are placed to be valuable as individuals, the science-contextualized models are to be prized as a group. In each case, information about both their art and science meanings is offered.

One aspect of the importance of these objects seems to be that they can count as both science and art. The interest in these objects by several parties at Cornell made logical both the division of the collection and its preservation by different hands. Somewhat ironically, these objects, which are made to count as both art and science, were divided into separate collections in order that the two different networks to which they belong could provide for their preservation.

Tacit Knowledge and Bloodlines

According to both early and more recent accounts, the Blaschkas' abilities with glass were unparalleled. They are imagined to have had nearly superhuman abilities with glass, and their abilities are associated with their family's history of glass making. The idea that the bloodline was as the means by which the models came into existence was cherished by of Leopold Blaschka. For example, he described his reasons for believing that no one else would be able to duplicate their work in a letter to Mary Lee Ware in 1889:

> Many people think that we have some secret apparatus by which we can squeeze glass suddenly into these forms, but it is not so. We have tact. My son Rudolf has more than I have, because he is my son, and tact increases in every generation. The only way to become a glass modeller [sic] of skill, I have often said to people, is to get a good great-grandfather who loved glass; then he is to have a son with like tastes; he is to be your grandfather. He in turn will have a son who must, as your father, be passionately fond of glass. You, as his son, can then try your hand, and it is your own fault if you do not succeed. But,

> if you do not have such ancestors, it is not your fault. My grandfather was the most widely known glassworker in Bohemia (Ware 1961).

Associating bloodlines and the Blaschka family history of glassmaking serves a specific type of cult of the genius, and it certainly would not have hurt sales: a combination of good breeding and individual skills are thought to produce the conditions for the Blaschkas' achievements. Emphasis on the family of glassmakers can be seen to follow both ideas about the cult of the genius and ideas about traditional craftsmanship and how artisanal skills can follow family lines. Family lines become conduits for tacit knowledge. The narrative at once emphasizes the lack of magic in their process and simultaneously raises the idea of character as an important aspect to the project. For example, it is often mentioned that the Blaschka family had roots in Venice, thus creating an association with Venetian glass making. Most accounts mention that Leopold followed his family into a career with glass, though while he was in school he apprenticed both as a goldsmith and as a gem cutter. His early work in glass included "ornaments, jewelry, test tubes and glass eyes (for people, and taxidermists' animals)" (CoBiD 2005).

For the science studies scholar, the importance of tacit knowledge is clear here (H. M. Collins 2001; Lynch 2002). Leopold invokes his bloodlines and refers to "tact" and potentially specialized knowledge that he cannot describe for his patron, Mary Lee Ware. He does not suggest that a specific technology is involved in the creation of these models. By indicating that their ability to make models does not come from an "apparatus," while claiming that the ability is something possible only through family lineage, Leopold maintains the uniqueness of the models, and therefore a reason for his patron to continue her support.

Rhetorical and Material Tools Employed Around the Models

The case of the Blaschkas' models presents a puzzle. How did these objects come to count as valid components in the knowledge networks of both science and art? Further, what resources have actors drawn upon to create a place for these objects in these two potentially separate knowledge categories? In order to explore these questions, we will look closely at the mythology built up around these objects (particularly around their creation), their presentation in different contexts, the way in which they serve science and push back against certain ideas about science and art, and the concepts they embody.

Beginning with the rhetorical resources deployed by actors on the glass models, and then moving to the material resources actors drew upon to make their case for the particular meanings for the models, this analysis explores the ways that people give meaning to objects.

Myths and Characters

The Blaschkas and their supporters engaged in a careful program of emphasizing certain ideas about their work and the characters of Rudolf and Leopold Blaschka. Selective emphasis has developed this positioning by the Blaschkas into a myth put forward by critics and analysts. I am strategically invoking the word "myth" to denote not fiction, but a repeated build-up of stories and ideas that have come to be part of the interested viewers' experience of seeing the objects. It is hard to see these models without also seeing certain features of the story of the Blaschkas. Additionally, as used here, mythology implies a selection of facts put together by people with a vested interest, either as creators, supporters,

curators, or scholars of this collection. It is not that the selected facts are not true, but rather that they form a "truth" about the models born from the selection of facts and qualities. In particular, I do not want to suggest that their careful study of the natural world was exaggerated by their correspondence or self-descriptions. The Blaschkas believed that the character of the naturalist and an eye for detail were important to the creation of the correct model. These models required "trained judgment," that is, the creators had to select the characteristics of the organism in question to model in order to represent the species rather than a single specimen.

Much of what we know about the way the Blaschkas conducted their work comes from their correspondence. The scientists of their time, particularly Professor Goodale at Harvard, frequently sent the Blaschkas specimens, and even seeds with which to grow specimens in their own backyard, for modeling (S. M. Rossi-Wilcox 2008). Accounts of artisans working with scientists often involve their direct hire and "disciplining" by scientists (Fan 2004; Smith 2004). The Blaschkas' engaged in self-disciplining through their use of images and specimens created for them by scientists, a move that allowed them to operate their business independent of direct disciplining by scientists. Their models circulated in the scientific community and were widely agreed to be excellent models for pedagogy and reference.

The economic valence of the Blaschkas' presentation of themselves as careful observers of nature cannot be separated from their interests in the natural world or from their interest in glassmaking. Commentators seem to be unable to resist mentioning that the Blaschkas took no apprentices and left no heirs, an idea meant to shore up the notion that their work was unique. This appeal to rarity and the

impossibility of duplication was meant strategically to add value to the existing models. The way that they, and therefore their work, were described as unique and impossible to duplicate situated them as a conduit for stable knowledge about the natural world in the form of three-dimensional models; it also helped to sell models.

Technical Aspects of Making the Glass Models

While almost nothing is known of the specific process used to create the glass marine models, a bit more is known about the process which produced the commissioned Harvard collection. The process of making the glass flowers must have been of interest to the Wares, who were underwriting the Harvard botanical specimen project. S.M. Rossi-Wilcox (2008) quotes from a letter Professor Goodale wrote to Mary Ware about the process the Blaschkas used:

> The worktables are covered with rods and tubes of glass, and blocks of colored glass, and spools of wire of different sorts. The bellows under the table are of the ordinary sort used by glassworkers and the blast-tube is a very simple one of glass. The lamp is made of a tin cup containing a wick, and solid paraffin which melts at a pretty low temperature is used as the fuel. In making the Phlox which they asked me to bring to you and your mother, they drew first of all a rough sketch of the relations of all the flowers to each other and to the leaves, and then began to mix some glass with colors to get the right tints. The corolla is drawn and formed from a tube of glass. Then the petals are formed and melted to the tube of the corolla. The stamens are melted in next, and then the whole thing is placed in an annealing oven to remain for a few hours. It took Mr. B. just an hour and a half to make the tubes and petals of the three flowers. It required about an hour to put in the stamens and add the calyx. Next, the buds with their twists are made and all are fastened to wires covered with glass. All of these are next fastened to a stem with leaves and the product is then ready for a little paint which is added with great skill where it is required. The molding of the shapes is affected by means of ordinary pincers and tweezers. With these clumsy tools they fashion the flat plates and turn them in any way they please. With little needles fastened in handles, they make the grooves and lines and fingerings of the edges. But although you may see him touch a flat piece of glass with his little metallic tools, you know that it is no ordinary touch which suddenly shapes it into a living form.

The phlox described above is pictured below (Figure 2.8).

Figure 2.8. Blaschkas' glass nosegay presented to the Wares in appreciation of their support for the Glass Flowers at Harvard. 1889.

Contemporary scholars have made use of this account, along with a knowledge of lampwork to describe techniques the Blaschkas likely employed (Miller and Lowe 2008; Rossi-Wilcox 2008). Early in their careers, the Blaschkas created models from glass rods that were commercially available, but after Leopold's death, Rudolf became increasingly interested in creating his own glass to control the color. One important aspect of creating the glass himself was that it allowed fine-tuning of colors. The paints used on many of the early glass marine models have proved difficult to preserve. By the time Mary Ware visited Rudolf's studio in 1928, Rudolf was making both the glass and the enamels for coloring the glass himself, which resulted in a lengthened creation process for the models (Daston 2004). The Blaschkas' techniques, however, were never as specifically celebrated as their observational skills and attention to details, all the way through

to the arrangements for shipping their models to customers. While a facility in glass making was certainly important to the creation of the models, because the Blaschkas were producing entirely for scientific buyers, and eventually for a single scientific buyer— Harvard University— knowledge of organisms and skills of observation were equally important to their ability to produce satisfactory models.

The Blaschkas faced a number of distribution challenges. Selling and shipping their models involved both social and technical work. Besides working with Ward's Science Establishment, the Blaschkas also sold models through Robert Damon, a natural history agent. He was their exclusive dealer beginning in 1880 for Great Britain and Ireland. Part of their agreement was that the Blaschkas would not be held responsible for shipping damage. A problem did arise with the British Museum, however, which claimed damage caused by shipping. Leopold Blaschka wrote in 1883 to Damon that his "chief purpose" [in] having an agent is to be exempted from such disagreeables" (Miller and Lowe 2008). The Blaschkas appear to have worked out the issue with Damon, because by 1884 the orders were again rolling in from the region.

Even for the contemporary curator, shipping the Blaschkas' work has proved difficult. In 1976, the glass flowers were shipped by Harvard for a Steuben Glass Company Exhibit in New York City. The models were transported by both hearse and airplane to decrease the vibrations they would have to endure (Schultes, Davis and Burger 1992). Shipping these models today remains a problem and requires a variety of techniques to prevent damage. The difficulties in creating and shipping the models were part of the cachet of the Blaschkas' operation, and the singular

nature of their creation, which seems to have been embedded in their person rather than in some specific technique, made the Blaschkas themselves as well as their works indispensable for institutions trying to amass collections.

The Roles of Photographs versus Models

Harvard University's exclusive contract with the Blaschkas prevented other institutions from replacing or expanding their own collections, and at the same time the objectivity of such truth-to-nature models began to fall out of favor (Daston and Galison 2007). According to Eisner's own account, by the time of his discovery of Cornell's glass models in 1957, the models had been out of use for some time (2008; Warmus 2001).

One explanation for the decline in interest in the Blaschkas' work would be that the rise of other technologies, particularly photography, replaced the glass models for scientific study. Cornell's Mann Library display makes such a claim: "Today we see photographs, film and videos of undersea creatures in more color, detail and motion than their models could ever show." Similarly, glass expert William Warmus writes: "… full color underwater photography of sea creatures would soon make the scientific study value of the Blaschka models obsolete" (2001; Mann Library 2002).

The idea that the models were replaced by photographs does not account, however, for the fact that the Blaschkas were able to find customers long after photographs were widely available. In fact, the Blaschkas began using photography to document specimens. On his trip to the American West, Rudolf Blaschka purchased many landscape photographs. The Blaschkas appeared to have owned

some photographic equipment because they made the image shown in Figure 2.18, which shows a set of models, probably ones that were ready to be packed and shipped from their home in Dresden to join other specimens in the Harvard collection. It does not, however, appear that the Blaschkas photographed specimens as a step in their model making process. Instead, they continue to use drawing techniques to plan the models.

A number of photographs were made on Rudolf Blaschka's trips to North America in 1892 and 1895 and to the Caribbean in 1892. The Blaschkas even created photographs of their finished work in their home in Dresden (Rossi-Wilcox 2008; Whitehouse, et al. 2007, 65). On his trip to the American West, Rudolf Blaschka purchased dozens of photographs now at the Cornell archives. These do not show individual plants though most do contain vegetation. It is not clear how these images were used but they do indicate the value Rudolf Blaschka placed on photographs.

While success in underwater photography would remain elusive until near the end of Rudolf's career, most of his later years were spent on botanical models, for which photographs had been widely available since 1839, when the Daguerreotype was invented through a combination of efforts by scientist Joseph Niépce and artist Louis Daguerre (Pinson 2011). Earlier, the camera lucida and camera obsucra (Alpers 1983) had been in use since the 1500s, as de Vinci described in *Codex Atlanticus* (1978-1979). As plants do not exhibit much motion, they were actually perfect subjects for the early cameras, which often required long exposures and considerable set-up time.

Prior to photography, drawing might well have been argued to have advantages, such as color and the ability to depict things in ideal mode, over preserved specimens. When Professor Goodale (S. M. Rossi-Wilcox 2008) introduced the Blaschkas' work at the opening of Harvard's collection, he cited the "drawings and paintings of Bauer and Isaac Sprague, of Miss Marianne North in the Kew Museum, or of Mrs. Charles Sargent in the Jessup Collection in New York" as adequate for study, as they were "remarkably spirited and truthful." But, he continued, they can only express two dimensions and thus the "third belongs to the imagination." Other artists working with three-dimensional models were declared in turn to be inadequate. The models had to be seen as at once faithful to the scientific images they were drawn from and possess additional scientific value, or at least more value than available alternatives. In wax, Goodale claimed, "flowers become like cheerless elements of funeral wreaths" and in papier maché they are "exaggerated and grotesque" (S. M. Rossi-Wilcox 2008). Goodale concluded that the answer to the problem of the best material for depicting botanical specimens came to him when viewing Harvard's Comparative Zoology collection and taking notice of the glass marine invertebrates, which suggested "a possible solution." Photographs, it seems, never came under consideration. Goodale's objection to two-dimensional depictions requiring imagination would disqualify them.

Lorraine Daston (2007) gives a different explanation. She theorizes that the models were the victims of their own life-like properties, and that this led to them becoming obsolete in the scientific community. She believes that botanists lost interest in these works precisely because they rendered every detail of the plant,

rather than emphasizing those characteristics necessary for identification. The models were so realistic that they could not actually serve as models because their fidelity to life obscured the particular characteristics botanists used to identify one plant from another. It is worth noting that many details that do not appear in the planning drawings make their way into the model (See Figure 2.9). The models became the wrong kind of model: in Max Black's terms they were not sufficiently different from the original to allow a "reading off" of identifying properties and, thereby, to be useful as scientific models (1962).

Figure 2.9. Bromelia pinguin L. Rat Pineapple, Rakow Research Library (Corning Museum of Glass 2011); Bromeliaceae, Model 451, 1894, Corning Museum of Glass.

Neither of these explanations is entirely compelling. Rudolf Blaschka did not see his work ended by any external force, financial or scientific. Rather he retired from work on the glass flowers for Harvard only three years before his death. He did indeed change his work patterns over time in response to scientific interests. To produce more lifelike tints, he began to make his own glass rather than working with fabricated rods of colored glass. The glass flower pictured in Figure 2.9 is an example. As scientific interest shifted to features visible only under a microscope, he

managed to make his models useful by moving away from representing individual plants in life size to creating scale items to allow closer study of micro-phenomena and microorganisms like the radiolarian (see Figure 2.10). Under the direction of Goodale, he also produced lifecycle models, including the reproductive cycle of the fern, to meet teaching demands for lifecycle training, rather than producing only model organisms with the primary purpose of identification of types and parts (Dyer 2008). Late in his career, Rudolf also produced models of agricultural species showing blights and botanical diseases, some of which are no longer common enough to be studied outside of these models (Rossi-Wilcox 2008). The study of nature does indeed change around the Blaschkas over the more than seventy years of their combined careers, but they changed their practices with the scientific community's evolving interests.

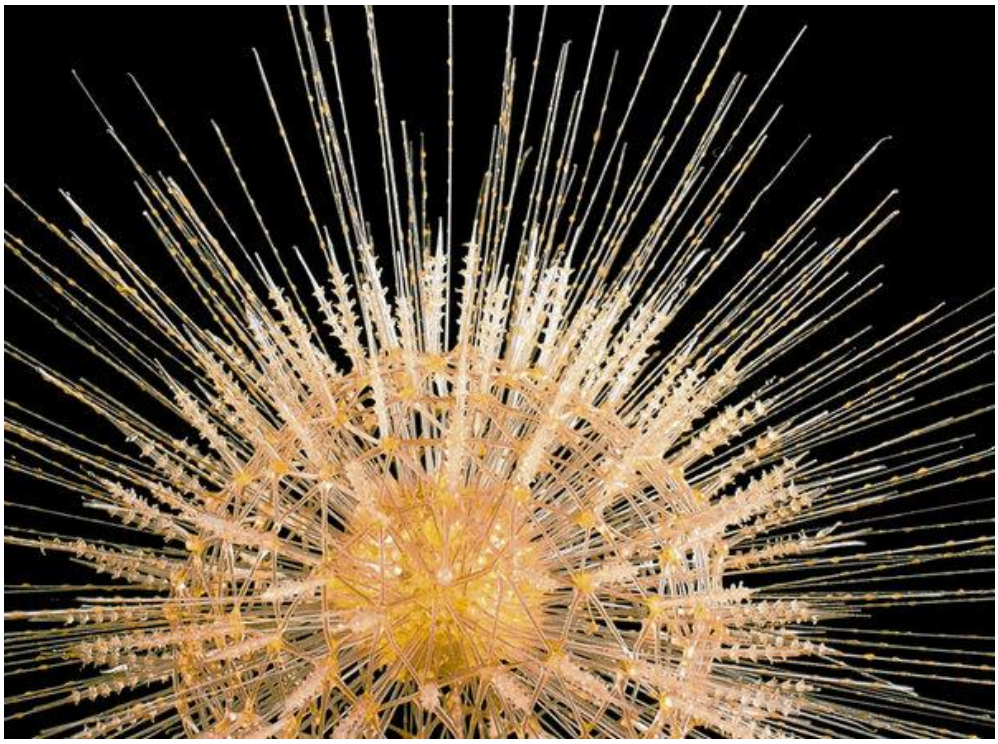

Figure 2.10. Enlarged scale model of the microscopic Heliosphaera actinota, Radiolarian. Natural History Museum, London

The Nature of the Glass Models as Representations

"A model," writes Blaschka expert Henri Reiling, "represents something, which it is essentially not" and that scientific models, in particular, postulate realities (2003). The Blaschkas, then, are at work turning glass and glue, things that are essentially not a jellyfish or radiolarian, into something that naturalists can accept as useful in knowing those things. In *Models and Metaphors*, Max Black (1962) describes several different types of models, including metaphors made material and models that are employed only as metaphors. Black names various types of material models: including the scale model and the analogue model, which requires a change of medium. Each type of model is meant to explain something about its original subject.

There are ways in which the glass models can be considered as an acceptable, or perhaps even better, way to display features of the organisms compared to other techniques. Reiling (2003) calls the models "better than nature," noting that they are "forever available." Specimens preserved in alcohol were understood to be poor at reflecting original shapes and colors. Scientific drawings and eventually photographs were two-dimensional. All of these potential representations reflected the organism in different ways. Glass stabilized the character of a fleeting organism and was thought to be so lifelike that it might be mistaken for the organism itself.

As Lorraine Daston (2007), has pointed out, Harvard's glass flowers cause people to talk about a sense of wonderment and to take great pains to be in the presence of the objects themselves:

> Although [the models] are representations themselves, they defy representation. A photograph of the glass model of a daylily or a strawberry plant looks exactly like a photograph of the daylily or strawberry plant in your garden…. It is the wonder of the copy that itself cannot be copied, which somehow is more authentic than the original. (2007, 254).

For Daston, wonderment and the interest in visiting the flowers themselves are a result of their ability to "defy representation." They are copies that are not easily represented since their representation tends to reflect on the organism rather than on the glass model; a photograph of the glass flowers looks like the flowers themselves rather than like a model of the specimen (Figure 2.9). What is being represented in the image is intriguingly confusing because viewers are aware that they are experiencing an image (this is not a recording of a bird sound that a listener mistakes for a bird), but are unsure of what they are seeing. When encountering a photograph of the Blaschka model of a diseased apple without more context (Figure

2.11), they may wonder if this is a picture of diseased apple or of a glass model of a diseased apple.

Figure 2.11. Malus pumila P. Mill. Emperor Alexander Apple (affected by apple scab disease). Rosaceae. Model 812 (1932).
Rudolf Blaschka (Harvard University Herbaria 2009). Photo by The Corning Museum of Glass.

Daston does not address the Blaschkas' earlier work, where it seems somewhat harder to make her claim since many of the models are easy to interpret as models, though certainly lighting and composition of the photographs play a role in our ability to understand them as models or specimens. For example, the solid black background in Figure 2.12 makes it easy to distinguish the parts of the model, but difficult to understand its size and positioning.

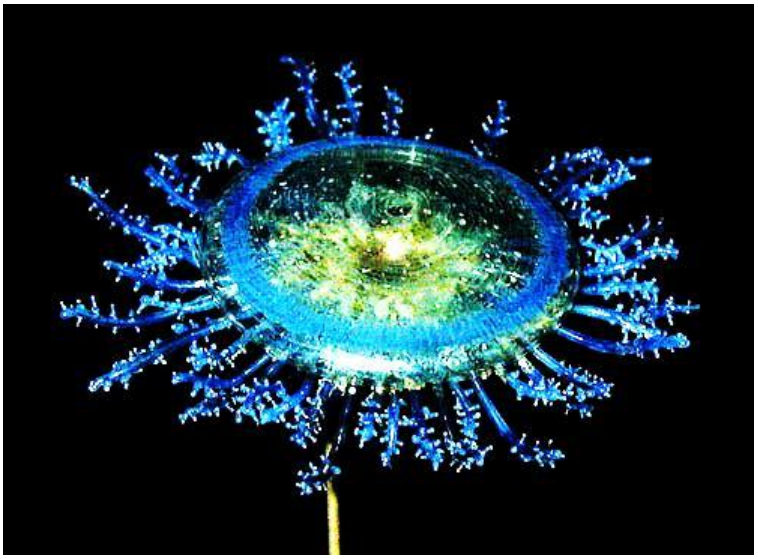

Figure 2.12.Glass Jellyfish Model at Cornell. Photographed by William Warmus.

Later in the Blaschkas' careers, when Rudolf Blaschka was sent on several fieldwork excursions, he continued to make scientific drawings that were consistent with the style of study drawings of their time. (See Figure 2.13 for an example.) These scientific illustrations show a representation of the plant, and by convention, include panel inserts of specific elements of the plant, often including roots, blooms, and seeds. This style of presenting the plant as separated parts can be contrasted with other scientific illustrations. Earlier images like Bartolomeo Bimbi's fruit tree (1715) present many different types of fruit on one plant, thereby showing the relationship between the members of, in this case, the citrus family (Official Publications Unit of the National Library of Scotland 2010). Fan (2004, 53) describes two important techniques: representing different stages of development (for example different stages of flowering and fruiting on one plant) and creating illustrations to give the appearance that they had been pressed like dried specimens.

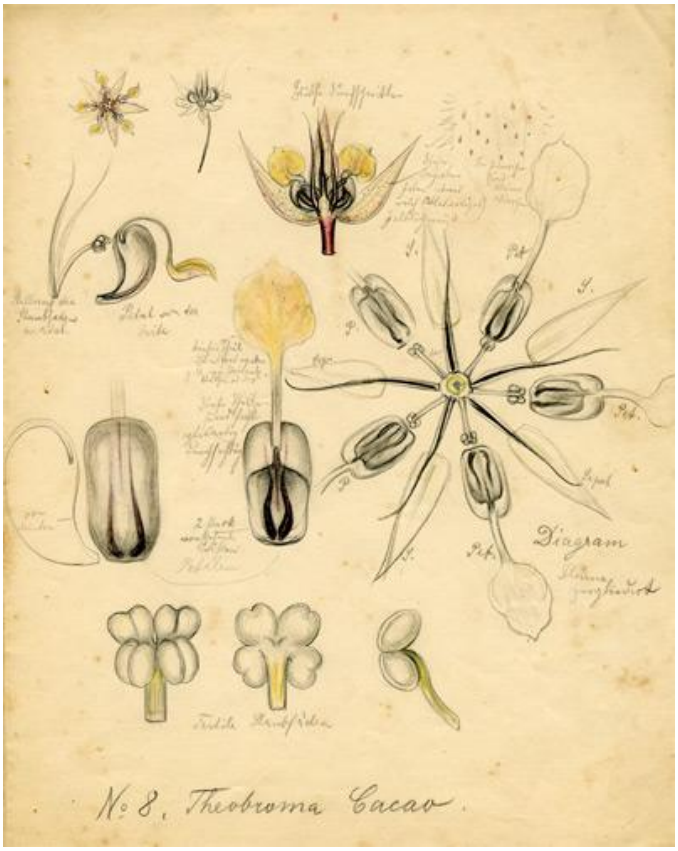

Figure 2.13.Drawing of a cocoa plant from Rudolf Blaschkas' field work trip to Jamaica. 1892.

While a scientific drawing may demand a certain manner of seeing and reading in order to understand the depiction, these three-dimensional representations make different demands in order to be understood as representational. This type of realism in representation offered an aesthetic quality that attracted the interest of scientists because it appeared correct and realistic to them. The Blaschkas aligned resources, including positioning themselves as adherents to the tenets of proper observation, in order to market models that would be accepted as valuable scientific pedagogical tools. Selling the glass models as realistic depictions of organisms required their acceptance as aesthetically correct. After the rediscovery of the models on Cornell's campus, curators there worked to

locate the glass models as art or science objects and justify their preservation by using the campus institutions affiliated with their respective art and science networks. There is, however, another resource the Blaschkas drew upon which helps us explain the rise and fall of these models as important scientific tools.

Style as a Material Resource. As noted above, much of the literature on why the Blaschkas' work fell out of favor is technologically determinist: the camera was a "better" technology for recording specimens, and once it became available it replaced the models (Warmus 2001). The idea that the camera replaced the need for glass models does not, however, explain Tom Eisner's use of photographs of the models in his book *Animal Adaptations* (Burnett and Eisner 1964). As argued above, photographs of specimens were widely available well before 1964, yet Eisner chose to offer readers photographs of glass models of a lugworm, sabella, and a squid, rather than photographs of the animals themselves. While it is possible that this was simply a "hobby" interest by Eisner, combined with the information about availability of photographs, it suggests that the emergence of the photograph as a scientific medium cannot explain why the glass models did not remain central to pedagogy. Instead, I will argue that the issue is one of aesthetics, in so far as the use of a style caused the models to be recognized as realistic and, therefore, to be sold to naturalists and science institutions.

In a special issue of *Historical Biology* on the Blaschkas' work, Rossi-Wilcox (2008, 15), former curator associate at the Harvard Glass Flowers collection, frames the issue of the Blaschkas' manner of creating an aesthetic charge in their work in terms of interpretation:

> Yet, one still wonders, did the Blaschkas provide their own spin on things? Where do they interpret nature to add to the didactic quality of the models? Did they cross the line as model-makers of faithful reproductions? Although I have not answered this question with the thoroughness one would desire, my preliminary observations suggest that from the beginning they made overall decisions sometimes based more on aesthetic considerations than 'science.'

Rossi-Wilcox goes on to explain that in 1896 Rudolf had confided in his fieldwork colleague, Walter Deane, that "We both, my late father and I, knew that there was yet a task for improvement with the color [sic] of the leaves and the general out-working of the models. But the circumstances led us to the opinion, that this problem, to make the leaves of the exact natural color when the light is shining through should remain forever an unfulfilled wish" (S. M. Rossi-Wilcox 2008).

For Rossi-Wilcox, Rudolf Blaschka's view that he had not done everything he wished with regard to accuracy in the models suggests that the models are forever inaccurate, and therefore making them required a series of judgments by the Blaschkas. To plan their models the Blaschkas drew their own illustrations based on scientific illustrators' plates and sometimes directly copied an illustration to use in creating their glass models. Figure 2.14 shows the Blaschka' drawing copied directly from Haeckel's Das System der Medusen (Reiling 2007). These judgment, instrumental for scientists in depicting a type rather than a single specimen, is a familiar idea from the work of Daston and Galison on truth-to-nature, and as these authors show there cannot be a real referent for any representation since elimination from the original is the essence of a model.

Figure 2.14. Blaschka study drawing from the Rakow Library Archival Collection. Probably by Leopold Blaschka.

The Rakow Library at the Corning Museum of Glass houses hundreds of drawings made by the Blaschkas, particularly from the early period of their work. Some of the drawings are precise copies from atlases, down to the pen strokes and colors. Part of what validated the Blaschkas models as acceptably scientific was the faithful rendering of naturalists' plates into glass. According to Reiling's research, including helpful notes he included when he organized the Blaschka papers for the Corning Archives, around 300 models were created from specific images in nearly 70 publications (Reiling 2003). Below left in Figure 2.15 is an illustration from Gosse's *Actinologia Britannica*. The style and colors in the model on the right is based on the anemone in the bottom right hand corner of Gosse's scientific illustration.

Figure 2.15. Left, P.H. Gosse, Actinologia Britannica, plate 5. The small anemone at bottom right is Anthea cereus Gosse. Right. Blaschka glass model of 'Anthea cereus' based on Gosse's illustration, collection of Oxford University, acquired 1867. Photograph by M. Nowak-Kemp, courtesy of Oxford University Museum of National History.

In 1877, the Blaschkas met Ernst Haeckel, a prominent natural scientist of the marine research station in Jena (Moses 2008) and the author of *Art Forms in Nature*, originally published in sets of color plates between 1899 and 1904, and as a complete volume in 1904.As mentioned above, Ernst Haeckel became a central interlocutor of the Blaschkas. In some cases, the Blaschkas created copies of his drawings to use as preparatory materials, sometimes element for element. Figure 2.16 shows two Blaschka models and the Haeckel drawings on which they were based.

Figure 2.16. Harvard Glass Flowers display. Two of Haeckel's plates from *Art Forms in Nature* and resulting Blaschka models.

Ernst Haeckel corresponded with the Blaschkas about specific specimens including the hydra, and the Blaschkas studied Haeckel's illustrations and scientific descriptions. In order to be considered realistic, the models needed to exhibit not only an adherence to the scientific norms of good models but also what, in the tradition of "truth-to-nature" could be called "truth-to-culture," (Daston and Galison 2007) an adoption of the correct style to appear plausibly real to viewers in the relevant context. Beyond representing the essential qualities of particular organisms or emphasizing specific features to enable identification, the Blaschkas' models, like Haeckel's drawings, domesticated unfamiliar organisms by coding them in a recognizable style (Haeckel, Breidbach, et al. 1998).

For Haeckel's audiences that style was the emerging movement of art nouveau, an international art movement that concentrated on organic forms and

incorporated elements of what was then known as “oriental” style, which in practice was primarily Japanese (Greenhalgh 2000). Haeckel himself played a role, particularly in its incarnation as an architectural style (Haeckel, Breidbach, et al. 1998). As I will explain shortly, the Blaschkas’ use of an art nouveau style did not simply make their models palatable, it made them interpretable. Their function as models in part depended on their aesthetic qualities. The models bound inextricably a depiction of nature with an evocation of culture.

First, it is worth noting some of the characteristics that made them fit so squarely into what would become the total style of art nouveau. Art nouveau was preoccupied with organic aesthetics. Formally, the style was characterized by stylized “whip-like” lines (Lindner 1897) and high degrees of symmetry, both across the page and at the level of details. Emblematic of this style were the graphic posters of the era, which frequently featured women with long flowing hair (wearing hair up was the social norm at the time, so these images were morally edgy), twisted by equally stylized wind and water, or in the case below smoke.

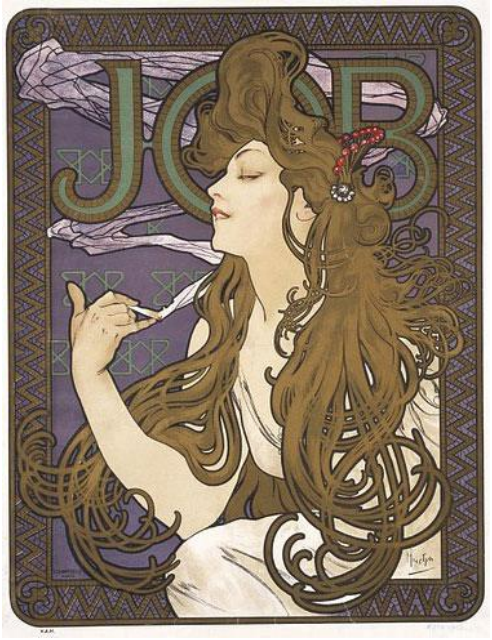

Figure 2.17. Alphonse Mucha, Color lithograph poster advertisement for Job cigarette papers, Paris c. 1897, at the Victoria & Albert Museum (Thompson 1971-1972).

This emphasis on symmetry carried through the plates of *Art Forms in Nature* and into the Blaschka models. Marine creatures made excellent art nouveau subjects, as did trees and floral motifs, because they lent themselves to a high degree of emphasis on symmetry while continuing to be recognizable.

In his introduction to Ernst Haeckel's *Art Forms in Nature* (Haeckel, Breidbach, et al. 1998), Olaf Breidbach explains that Haeckel's plates fit "seamlessly into the repertoire of Art Nouveau forms" (1998, 14). *Art Forms in Nature* was originally published in sets of color plates between 1899 and 1904 and as a complete volume in 1904. Haeckel's nature was brightly colored and symmetrical. His plates sometimes presented related species for comparison in shared "natural" settings. As mentioned above, the effect of choosing to represent the natural world in an art nouveau style was to domesticate the unfamiliar: Haeckel needed to

ground these new forms in a visual language his readers would find familiar (Haeckel, et al. 1998, 21-23). This interpretation of nature, which emphasized detail and the color conventions of art nouveau, made his work approachable for generalist readers of his time, as well as supporting his points about the beauty and variety of nature. Breidbach goes on to argue that Haeckel's work influenced the formation of art nouveau (Haeckel, et al. 1998, 24-28). While Haeckel was very influential on the architectural style, as a fine arts style, art nouveau was already well entrenched and available as a frame for seeing the world. Haeckel employed it to make an unfamiliar part of the natural world, the ocean, familiar. This dual quality of art nouveau, its ability to render the specimens interpretable while also being at the cutting edge of representation, made it an appealing way to depict Haeckel's natural world.

Figure 2.18. Photograph of models in the Blaschkas' Dresden home before they were shipped to the Harvard Collection. Probably by Rudolf Blaschka.

The Blaschkas' interactions with Haeckel and other scientists of the time informed their model making. Scientists were their market and their best source of the information and materials required to create their glass modeling business. When the scientific standard for representations was depictions of fanciful sea life, the Blaschkas produced models that reflected the foreignness of these ocean creatures in a style that audiences could interpret (Haeckel, Breidbach, et al. 1998). The Blaschkas were creating sea life as they saw and imagined it, based on the scientific illustrations and descriptions being produced by scientists of their day. The Blaschkas' observations were dependent on trained seeing. Many of their models, especially earlier in their careers, were based on studies of images created by other naturalists, like those produced by Haeckel, but they had to reimagine the organism from those materials in order to create their models.

As the scientific eye became more accustomed to understanding organisms through photography, the Blaschkas' work began to reflect those sensibilities. Scientists' identification of the "correct" model (that is, their preferred model) relied on it looking realistic, which necessarily involved the use of a style the buyers would recognize as realistic, in the case of the Blaschka's early works (Abell 2007; Gombrich 1986, 205). Aesthetic values from the art nouveau period (1890-1905) were projected onto their construction of the natural world but later discarded, to be replaced by a different style, once sensibilities changed and altered preferences for scientific instruments. As Blaschka expert Henri Reiling (2003) puts it, "If …Blaschkas' glass models are presented in the context of their contemporary decorative arts, they presumably would be recognized in retrospect as related to

expressions of Jugendstil and art nouveau— a relationship that already has been obvious for the knowledgeable eye" (235).

The Art of Glass (Arwas, Newell and Gallery 1996), a catalog of important glass makers from art nouveau to art deco, lists the Blaschkas' work and notes that "expert glass decorator Leopold Blaschka" contributed the first three dimensional method by which marine life could be studied (1996, 97). The authors quote from an 1865 committee report of the Natural History Society of Thorthumberland, Durham, and Newcaselt-upon-Tyne, which comments that they are the only recent museum aquisiiion of note because they "afford a means for representing a class of animals hitherto unrepresented in our Museum." The authors go on to note that the Blaschkas used a cold painting method which built on skills of their time, but that their "dexterity and artistry in glass painting" continues to make their models on-of-a-kind examples.

The change in the Blaschkas' work over time was a result of their customers' constant pursuit of models to represent their scientific interests. As a result of their customers' changing tastes, the Blaschkas changed their models. By the later period, when Harvard was their sole customer and plant identification was no longer the primarily focus of botanical research, the Blaschkas found it necessary to meet their customer's demands in a variety of ways, including the creation of life cycle models (notable the fern reproductive cycle) (Rossi-Wilcox 2008). These shifts in subject matter, however, were not the only changes to the models underwent.

Following Lorraine Daston and Peter Galison (2007), we can see that the source of the objectivity shifted from the model maker to the professor-scientist-

consumer. The Blaschkas' customers' sense of what was lifelike was subject to changing artistic conventions. It no longer made sense to render an organism in a particular style without the careful selection of the objective eye of a scientist to be sure that the model was correct; indeed the notion of objectivity is undergoing changes. In Daston and Galison's account, the judgment of the professor or scientist as observer determined that objectivity. Extending this to the Blaschka models, scientists judgment determined was "correct" according to the scientific standards of the moment. In hindsight, with ample evidence for the models as examples of art nouveau, it is possible to say that if the models were "correct" scientific representations in their moment, and their aesthetic qualities are ignored, then the Blaschka models style must have been either an acceptable style to the scientific community or entirely invisible to the Blaschkas contemporaries. In either case, it seems that style is present in scientific representations.

Conclusion

Both the Blaschkas and the actors at Cornell configured meanings for these objects according to their political goals: for selling the models, positioning them in museum, raising funds for their preservation, and enrolling them in conservation projects. The Blaschkas embraced two identities; they wished to be thought of both as glass makers and as contributors to the project of natural history. They carefully positioned themselves as observers of the natural world and singular talents in glasswork, in order to sell their wares. Their capacity to create accurate (and eventually necessary) models for marine study can be seen as both necessary to selling models and a result of their model sales. Cornell supporters of the models

were happy to make claims for the models as important in science or art so long as the models were preserved. In both cases, the categories of art and science were made flexible and enrolled by actors as political resources for these agendas. In addition to revealing this categorization process, this study lays the groundwork for considering the relationship between aesthetic styles and scientific models and the potential uses of style as a resource for meaning making. The indivisibility of artistic and scientific modes of thinking and their appearance together in many objects and people suggests that the categories of art and science are constructed by rhetorical and material means. Further both the categories themselves and the objects and people they contain may be reconstituted into elements of the other network or reconstructed in new ways.

Daston and Galison (2007) have shown that many different kinds of objectivities exist at one time, but our culture's preoccupation with the photograph, at least among laymen, makes photorealism a sign of objectivity. Yet the connection between photography and realism was not automatic. During their early careers, photography would have lacked color, and this would have posed some challenge to identification and study when colors were required for identification or understanding. Critics are consequently preoccupied with pointing out that the Blaschka models as depicted in photographs cannot be differentiated from actual specimens of the organisms. An interest in creating models that can be interpreted as specimens through the photographic lens may be a by-product of the type of objectivity the Blaschkas were pursuing in the later parts of their careers.

Daston has explained the progression of understandings we have of nature. In her formulation, what constitutes the natural verses the man-made changes over time and in relation to shifting definitions of nature. Commentators of the Hellenic age discussed whether what to the contemporary eye is clearly a crafted cameo might in fact be a naturally formed object; their confused was possible because of different conceptions of the nature of the natural world (Daston 1998). Analogously, we might ask how the conception of "life-like" changes over time and in relation to the ways we value life-likeness. It is easy to imagine future viewers who would not view glass models to be lifelike; what constitutes a good representation, in this case of lifelike qualities, can change in both science and art.

The two styles we can observe when viewing Figures 2.11 and 2.15 side by side met the demands of scientists at different times. The first I would characterize as an earlier style with a flair for what we now might call the fantastical or perhaps even art nouveau. The later style I will call photorealism. While it is not possible to find textual evidence of an intentional shift in the Blaschkas' style, I believe that if we are willing to accept the visual as evidence, something dramatic has happened. In order to meet market demand and as a result of copying the sketches of other naturalists, the style of the Blaschkas' models changes.

In my view, the Blaschkas' creations are not only objective but also aesthetic in their time. The aesthetic qualities of the models function to guide interpretation, framing the object as something we can see *through* as a cultural lens – to interpret not only as the natural state of organism but also as the natural way of seeing. Style makes culture visible. Aesthetics was simply one resource the Blaschkas leveraged

to achieve their ultimate aim of selling their models to the scientific community. The Blaschka models implicitly argued for the value of particular details in representations: symmetry, particular colors, depiction of specimens as if they were alive (turgid looking rather than flaccid in preservation containers), and three-dimensionality. The Blaschkas' aesthetics were political in that they signaled participation in the "correct" and "accurate" styles necessary to bring forth acceptance and sales in the scientific community. In Daston and Galison's terms, the objectivity is found, in this example, to be subject to not only particular historical and cultural moments but also to specific aesthetic moments.

Both styles—art nouveau and photorealism—were praised in their moment for accuracy, and what Daston and Galison would call truth-to-nature, since they both represent a type rather than an individual– but they are clearly rather different styles. I would argue that these styles are not merely artistic flourishes but reflect a change in scientific seeing. I suspect that the later style looks more "real" to us precisely because we are more used to seeing the world in a photorealistic style. Contemporary viewers of the anemone in Figure 2.15 might have seen it as more realistic than viewers see it as today. Perhaps the scientific eye is being shaped by style and the accepted model has more to do with style than we may have previously recognized.

The impulse to do away with these subsequently subjective and dated representations, such as the art nouveau models, can only lead us to ask what style the later Blaschka works represent. Surely it would not be credible to believe that we have at last reached an objective style. The style of the latter Blaschka models

can fool a camera and, therefore, for the modern viewer who has come to accept cameras as producing a particular type of realism, it is a style we still embrace today. The aesthetic is invisible to contemporary viewers, so it can still be contended that the models look like the real thing precisely because Rudolf was able to move from an art nouveau-involved style, which functioned to help make the early models acceptable as science to a contemporary style, which captures a new sense of the correct look for the scientific model.

While they always maintained that they were glass artisans, the Blaschkas took pains to fashion themselves as observers and naturalists, as their livelihoods were tied to the acceptance of their models as scientific. As mentioned above, Cornell supporters of the models were happy to make claims for the models as important in science or art so long as the models were preserved. Both the Blaschkas and the actors at Cornell configured meanings for these objects according to their political goals.

Individual actors' reasons for attempting to draw particular meanings from these objects included wanting to sell them, a belief in their use as examples of craftsmanship and a desire to use the models to further a conservation agenda. This case reveals the use to which the categorization process of labelling the Blaschka models "art" and "science" served different actors' agendas. The categories of art and science are flexible and were used as political resources for these agendas.

CHAPTER 3: THE PRACTICES OF TACTICAL MEDIA

Introduction

As we have seen, it is possible to compare the knowledge communities of art and science and study their interactions by following the objects they create. This chapter presents a case study of a contemporary art project, ®TMark, which bridges art and science networks. The project is an example of the work of a new media art movement called tactical media that uses the media as its material, though it has grown past this initial definition. The most often cited definition of tactical media comes from Garcia and Lovink's "ABCs of Tactical Media": "Tactical Media are what happens when the cheap 'do it yourself' media, made possible by the revolution in consumer electronics and expanded forms of distribution (from public access cable to the internet) are exploited by groups and individuals who feel aggrieved by or excluded from the wider culture" (Garcia and Lovink 1997). This definition has been expanded by tactical media artists to include the use of other technologies to make a variety of political points.

®TMark spans the borders between technology, science, politics, and art. ®TMark is an art piece website that rose to prominence during the expansion of the internet in the early 1990s. As corporations rushed to set up a web presence, ®TMark came onto the internet scene mimicking logos, slogans, and policy statements. ®TMark's website declares that it offered "complex solutions for a simple world™" (2000a) and was meant to deliver a stinging critique of corporate mentalities and corporate liability law. In particular, the website emphasizes the status of corporate personhood. Behind its corporate business-style veneer,

®TMark is a satirical, web-based, tactical media project that attempts to connect activists, artists, and financiers to facilitate political projects.

In order to see how actors rhetorically and materially shape their works as art and as science, this chapter investigates a series of strategies employed by tactical media artists. The chapter considers how tactical media actors create mythologies and characters to support their work, use a critical edge and humor, and employ a specific concept of the agency of technology to create projects with different standards of what counts as "working" to further their political agendas. In practice, the categories of rhetorical and material strategy are combined in nearly every element of tactical media work and serve to reinforce one another.

Actions on the boundary of art and science, what Amy Youngs (2000) has called "smearing," confirm the STS concept that the boundaries between disciplines are built by actors with specific purposes, though a particular boundary may outlive that purpose. Through acts of "smearing," the actors in this chapter demonstrate that these boundaries are constructed and can be deconstructed and reconfigured. In tactical media work it is difficult to separate which parts are art and which parts are science, both in a single project or even in an actor's own practice. For many tactical media artists, science and technology are interchangeable terms. Because these twin modes are co-produced and reliant on one another in a way that makes easy division impossible, tactical media artists tend to treat them together.

While it would be far easier if one could point to a group of technologies as defining tactical media, it is not the technologies themselves but a very loose philosophy and general manner of using technologies that bind together the tactical

media community. The technologies are used in a variety of positions: as hooks for the audience, as means of a critique, and as subjects of the critique. Garcia and Lovink point to "crisis, criticism, and opposition" as the source of power for tactical media. Tactical media artists play upon the perceived and material power of technologies, returning again and again to aspects of technological media for different parts of their projects. Technologies are used as evidence or proof of a point of view and as conduits for passing along information.

For Garcia and Lovink, tactical media projects inherently cross borders: "Tactical media is a qualified form of humanism … an antidote to the newly emerging forms of technocratic scientism ... [it]) crosses borders, connecting and rewiring a variety of disciplines." While many interactions are web-based, it is important to note that this is not an entirely web-based movement. Much of the work of organizing and creating the environment for new projects takes place at in-person conferences like the "Next Five Minutes," an often-cited origin point for collaborative tactical media projects.

For the tactical media artist, politics are never far from knowledge creation. The technical skills they hone and the results of some projects are explicitly political. Sheila Jasanoff's (2010) work on climate science has pointed out that scientists in certain fields are always aware that their data are political objects. It is only the "settled" science or the technology not currently under risk evaluation that can see itself as non-political, and tactical media's science and technology focuses are inherently disruptive, questioning and turning even generally accepted knowledges into opportunities for inquiry. Like disempowered groups' constant

awareness of the political nature of identity, tactical media artists are offering alternative versions to our understandings of technology and science, and therefore think of their knowledge-making as political acts.

I do not wish to claim that all art everywhere is political or is creating knowledge, but I also would not want to be misunderstood as asserting that the knowledge-creating power of tactical media in some way derives only from its involvement with science and technology or the acquisition of technical skill. Instead, in an expanded view of knowledge production, one that takes in the knowledge production of spoon benders, medieval herbal healers, and artisans, we cannot ignore the arts as a potential community of special skills and ideas that can constitute a knowledge community.

When tactical media artists are making art, they are also making knowledge and waging politics. While ®TMark is attempting to shape agreed upon public knowledge, AIR has developed a new method of air quality testing which exposes the politics of the traditional method while also producing new air quality figures to be considered. Like all new areas, the boundaries of the work are being defined as work is done, and analysts must rely on exemplars to point the way toward definitions of what counts as successful work. ®TMark is admired by tactical media artists as "clever," "professional," and "well-known." The values expressed by these words of praise for an exemplary project in the genre are a good starting place to think about the goals that tactical media artists have for their own work.

Methods

My method for this project was a combination of interviews and archival research. The variety of formats that tactical media artists chose to use to communicate with me (face-to-face in their offices and homes, by phone, via Skype, via e-mail, and through Facebook) offers a glimpse into their lifeworlds and their styles of self-presentation.

The nature of tactical media is ephemeral. The primary medium for ®TMark and therefore the primary resource for this project was the internet. It provided both records of ®TMark activities and a resource for my effort to contact interviewees. Materials on the internet can be difficult to preserve, and tactical media projects make sense only in specific contexts. The projects are generally designed for immediate impact; only rarely are attempts made to catalog and store the materials. By the time my research began the peak of ®TMark had passed, and many ®TMark website links were dead or directed away from the site to other tactical media projects. This meant, however, that many people were ready to comment and reflect on ®TMark, since they considered it an important project in the history of tactical media.

Although the internet may delete its history, footprints often remain, and I have attempted to reconstruct a sense of the website from a combination of the internet archival tool "The Wayback Machine" (The Way Back Machine 2007) and the Nettime listserv's posted conversations. There were some materials, however, including versions of the website, which I was never able to access. My interviews were semi-structured and took place in a variety of formats: face-to-face in offices

and homes, by phone, via Skype, via e-mail, and through Facebook. I interviewed tactical media artists who were both directly and indirectly involved with ®TMark. I also interviewed journalists, tactical media artists who worked on other projects, and scholars with knowledge of the area. Many tactical media artists are academics, and I interviewed individuals in their capacities as artists and as professors. Most interviews lasted two to three hours, and most involved a follow-up interview, often by e-mail. In all, the intensive portion of my interviewing lasted approximately a year and a half.

Of course, there are important pitfalls when investigating individuals' historical memories. What seemed at the time to be a passing fad in the contemporary artworld may now be inflated in importance. The way a person remembers having first encountered a certain group of people or a website may now be overshadowed by the moment in which that group or website took on an important meaning to his or her own work. For a project like mine, however, there is a certain truth to misremembering in its role as part of narrative-making. This project is not reliant on the specific moment of understanding or particularly interested in the accuracy of the historical moment at which ®TMark came to be understood as a valuable project. To further complicate the matter, some of my interviewees, as I will discuss later in the section on Identity, took my research as a platform for continuing tactical media work. Given the ambiguities inherent in narrative constructions, the presentation of the self-common in interview settings, and intentional identity manipulation, we must concentrate not on what the "facts of

the case are," but instead on the strategies and meanings these actors are employing as part of their work.

Tactical Media Projects

In order to investigate what tactical media is and to offer some context to the ®TMark project, I interviewed a variety of tactical media artists who were not directly involved with ®TMark. Tactical media often requires specialized contextual knowledge in order to appreciate the whole meaning of the project, so these actors can also be considered the audience for ®TMark, along with a host of other interested art viewers, educators, and political activists. These examples by no means cover the full scope of tactical media, but instead are offered as examples of the variety found in this hybrid field.

Critical Art Ensemble

The Critical Art Ensemble (CAE) is an artist collective that has created a number of tactical media projects, which they define as situational, ephemeral, and in opposition to authoritarian (particularly capitalist) institutional regimes. In addition, CAE holds workshops to teach others about tactical media. Formed in 1987, Critical Art Ensemble has produced important installations in a variety of media. CAE projects routinely require many different technical skills and know-how, as they have worked with electronics, biological materials, and digital art. One project was focused on the politics of names and proposed a dual renaming of Victoria Square in Adelaide, Australia (which some local people wanted to rename using an Aboriginal name). The project was accomplished by changing the signs overnight. Though the signs were removed, the city council then followed the

suggestion and gave the square two names, officially adding the name of an aboriginal leader “Tarndanyungga."

CAE has produced several important volumes: *The Electronic Disturbance*, *Electronic Civil Disobedience & Other Unpopular Ideas*, *Flesh Machine: Cyborgs, Designer Babies, Eugenic Consciousness*, *Digital Resistance: Explorations in Tactical Media*, *Molecular Invasion*, and *Marching Plague*. Detailed manifestos explaining the intent of TM artists and their philosophies can sometimes be difficult to come by, so CAE’s books, which are widely available, have been influential in the field. CAE’s work is anti-capitalist and reaches out to or includes local populations in order to involve more people in political art. In 2004, the group received a great deal of media coverage when Steve Kurtz, a member of CAE, was arrested in Buffalo, N.Y. in conjunction with a post-911 terrorist investigation, because he was working with biological materials in his home as part of his work (R. Wilson 2008). Although Kurtz was never indicted on bioterrorism charges, he was charged with mail fraud, but by 2008 all charges were dismissed.

Preemptive Media

A 2004 exhibition “Swipe” by Preemptive Media (Singer, da Costa and Schulte 2004) attempted to make people aware of how their personal information is linked on ID cards and what information is public or available on the open market by pay subscription. The project consisted of a bar set up in conjunction with an art opening at a museum, as a short term installation, “Swipe” functions as situational performance art. As expected at museum openings, the bar offered a complimentary drink to each patron. When the patron presented identification, ostensibly for age

verification, the strip on the back of the patron's identification card was swiped. Using commercially available databases, the artists created a print-out of personal information, which was served along with the patron's drink. This project required both an intimate knowledge of what Singer has called digital doppelgangers (2002) and technical skills to make the installation run smoothly and prevent backups of data orders. Singer also felt that their best audience would be made up of people who were naive to the artwork until their data were served. Particularly as the project became better known, the reactions of the audience to the work changed from understanding the political message that their information could be accessed by a stranger to being simply curious about what the artists could find out about the patrons.

In 2006, Preemptive Media created a project called AIR, which offered participants a chance to use a handheld device to map the air pollution in their area. A related project, "Pigeon Blog," involved strapping air pollution sensors and GPS backpacks onto pigeons in order to capture more accurate data about air pollution in southern California in order to draw attention to issue around air pollution and how it is monitored (http://www.pigeonblog.mapyourcity.net/). Since standard sensors remain stationary, while pigeons and people move, the artists hoped to offer a more realistic picture of the pollution profile that individuals encounter as they move around their cities. A map of the pigeons' sensors outputs is available in on the internet (da Costa 2006).

Natalie Jeremijenko

Natalie Jeremijenko has created a number of projects, including OneTree(s), which involved planting cloned trees in different locations around the San Francisco Bay area in order to raise questions about nature versus nurture. Jeremijenko's works function as tactical media because of their situational nature and because of their emphasis on public involvement. As part of her Bureau of Inverse Technology (BIT), she put together the feral robotic dog project, which draws attention to pollution issues. She also has a health clinic in New York City which offers prescriptions for healing the earth. Jeremijenko's projects have required technical skills ranging from understanding the process of cloning walnut trees to robotics.

Her 2006 Feral Robotic Dog project involved a combination of thought experiment and design project. The thought experiment involved considering what it would be like if the then popular toy robotic dogs were, in fact, "motile" beings, waiting in our homes and offices to someday take over the world. For the design portion of the project, the dogs were outfitted with sensors to locate pollution. The project also tapped into ideas about dogs by suggesting that they might be able to develop pack behavior and collectively map their surroundings using GPS technology. The feral robotic dogs successfully created media events that brought attention to issues about pollution and how the public receives and understands pollution issues.

Jeremijenko is clearly very deliberate in the positioning of her work. In art circles, she is accepted as an artist, in interactions with the human-computer interaction community she is accepted as a human computing interaction

researcher, and in STS circles she is perceived as an activist science studies scholar (Weiser and Brown 1995). As the artist, she is also aware of her power to influence the labels that will be used to describe her and her projects.

Mark Shepard

Mark Shepard works with technologies of location and considers the ways that these often top-down technologies could work from bottom-up. Shepard's work requires proficiency in programming and troubleshooting with electronics, as well as electronic systems design. His 2007 project "TacticalSoundGarden" was a free software program that allowed wireless device users to attach sounds to geographic locations within a given space using a GPS system. For example, a user might tag a courthouse with a political message that others could hear via their mobile devices and software as they passed by. Passersby could choose to listen to the message or add one of their own. The project enables a community of users to enter and edit sounds of their choosing to create a public sound garden, while potentially evading the gaze of authorities and non-users.

Paul Vanouse

Paul Vanouse has created a variety of projects that range from tactical media to bioart, a mixture of art and biology. "Latent Figure Protocol" (LFP) reflects concerns about the way the public understands the meaning and validity of DNA "fingerprinting." This pun on "latent fingerprints" suggests that Vanouse's work reveals something previously hidden about DNA "fingerprinting" and its uses. Here genetic material is placed into gel electrophoresis trays that are fitted with cameras to show the gels on the walls of the gallery, as samples being run in the gel

electrophoresis trays. When completed, the tray produces a pictorial image: of a copyright symbol, a skull and cross bones, or a zero and a one. Vanouse often adds variety and bolsters his case for the complications of this technique by showing videos taken at earlier times of the gels running to produce images other than the live one in the gallery. As well as showing the images and the gels that created them, Vanouse gives a lecture-style performance in which he describes his technique. Proteins move along the gel based on their size. The various sizes are achieved through cutting the DNA in specific places. These places are determined by 'restriction enzymes' specific enzymes that are used to do the cutting. Vanouse explains that he has written a computer program that uses the fact that different enzymes cut the DNA to different lengths, allowing him to organize the enzymes to produce any picture he designs. He uses this technique to critique DNA fingerprinting technology and suggests that, although the name sounds as if it provides solid information, the technique is more subjective than most people think. These public interactions create a place for viewer feedback and discussion.

As Vanouse puts it in the technical description of the project on his website: "The LFP imaging process relies upon knowing what size DNA fragment is required for each band to move at the proper speed to make the correct image. This is essentially doing molecular biology in reverse. Usually scientists use imaging techniques to determine an organism's genetic sequence, whereas LFP utilizes known sequences in online databases to produce "planned" images" (Vanouse, Artwork 2007). The images Vanouse chooses are meant to provoke questions about the way our culture understands the meaning and uses of DNA "fingerprinting"

technology. The piece required that Vanouse be intimately familiar with the technical aspects of gel electrophoresis, to the point that he is able to tamper with it to design this project. He further inflects new meanings on the device in the public sphere and displays the gels themselves in personal exhibitions and as projections on the gallery walls so they can be seen and inspected easily by audiences, unlike their scientific counterparts, which are usually tucked away in lab spaces. Vanouse projects the gels onto the wall during the display as well as projecting prerecorded gels that make other symbols. The piece calls into question not only what we know about DNA fingerprinting technology, but also how much we can trust other opaque biotechnologies.

This sampling provides us with some representative projects in tactical media. Tactical media artists work with a variety of technologies. They both critique technology and use technology to make the critique. They explore politics in and through technologies. I turn now to a discussion of ®TMark specifically, before analyzing how tactical media actors rhetorically and materially shape the context that surrounds their projects.

®TMark

The tactical media project ®TMark is well known in new media art circles, and remains a model for this type of work. ®TMark presented itself as central to tactical media work and a primary presenter of tactical media news. The website was used to draw attention to the legal disputes surrounding GWBush.org, the tactical website that popped up under searches for the G.W. Bush's web website but mimicked and parodied the campaign webpage. ®TMark's was a node, in actor

network theory terms (Callon 1986), in the tactical media network. It was at once a project unto itself and also a central place to learn about other tactical media projects. Additionally, it drew coverage in the mainstream media, which attracted new audiences.

®TMark was founded by two artist-professors, Igor Vamos and Jacques Servin. Vamos studied studio art at Reed College where he founded a guerilla street theater group. He is currently an associate professor in the Department of the Arts at Rensselaer Polytechnic Institute. Servin is an associate professor at the Parsons New School for Design. The two have long and illustrious tactical media careers. In their work, they have been adept at confusing the chronology of their projects. SimCopter was a videogame which was purportedly modified by the artists to replace "babes" in the game with "half-naked boys." Sometimes Servin claims his SimCopter work was inspired by ®TMark; at other times that SimCopter inspired ®TMark. ®TMark's references encourage readers to "search the web" for more information about projects like SimCopter.

Vamos and Servin are widely known as Mike Bonanno and Andy Bichlbaum, the two primary characters who make up the Yes Men and engage in "identity correction." As Yes Men, they pose as spokesmen for the World Trade Organization (WTO) and as industry leaders. The Yes Men's website claims to represent 300 imposters worldwide. The Yes Men could be said to have begun their identity correction practice in elements of ®TMark, since its founders collaborated on both projects. For ®TMark, Servin poses as Ray Thomas, CEO of ®TMark. Similar to

®TMark's claim that they wanted to connect "Cultural Workers" with financial capital, the Yes Men actively solicit donations.

As the BLO (Barbie Liberation Organization), these artists offered a gender critique project (®TMark, Inc. 2000c). The timeline for this project is uncertain since some accounts list the organization as being founded as early as 1989, but most of the press coverage seems to have occurred around Christmas of 1993 (http://sniggle.net/barbie.php). The group contacted media outlets offering news feed and press releases that reported that Barbie and GI Joe dolls purchased from toy stores had had their voice boxes switched. The Barbies said things like "Dead men tell no tales," while the GI Joes asked, "Want to go shopping?" It was never clear whether any of these toys were actually ever placed in stores or, in fact, even made, an issue we will return to later. What is clear, however, is that the press releases from the BLO produced a short media flurry, and descriptions of the project persist on the web nearly 20 years later. The ®TMark website directs viewers to search the web and offers some ideas for the types of things they will turn up.

®TMark claims BLO as its first prank, but this is difficult to believe, as BLO took place before ®TMark existed as a website. Other accounts state that the first ®TMark-sponsored project was a hack for the videogame SimCopter (Servin 1996). According to a press release, on certain dates the hack generated "himbos" (a pun on "bimbos"), men in swim trunks who appeared on the screen and kissed. Still other accounts state that this action along with others was claimed as an ®TMark action several months after the announcement that SimCopter contained these images.

®TMark's declared goal was to provide activists with a way to organize that would prevent their exposure to liability law. Corporations, ®TMark's makers reasoned, were protected from their actions by corporate liability law: "®TMark company activists enjoy anonymity, limited liability, and increased exposure to resources and other activists" (®TMark, Inc. 2000a). If you click through the website, you will learn that ®TMark claimed to be a collaboration of activists and funders who wanted to find each other in order to "direct the flow of cultural capital."

One major ®TMark project, which as of 2011 can still be viewed on the web, was ®TMark's "mutual funds." In theory, activists posted project ideas for "mutual funds" that were managed by various "fund managers" who are important figures in the art and activist world. If you click into the mutual funds page, you will see a grid of potential project ideas and information about whether the project is soliciting funds or workers. Projects are coded in relationship to risk and social justice topics such as "War," "Biological Property," "Alternative Markets," and "Labor."

If you click on the "Environment" fund, you can select to provide funds or labor for the following project: "An employee of one of the three largest car manufacturers in the U.S. should cause at least hundreds of cars to be shipped with gas tanks that have a capacity in between half a gallon and a gallon of gas only (the cars should be able to go about eighteen miles before refueling). At least some of the cars must be sold, and the media must report on it" (®TMark, Inc. 2000b). In the "Biological Property Fund," projects range from animal rights critiques to projects dealing with biological property rights and tampering with public perceptions of

what medical and genetic technologies mean and can do. For example, one project proposes that workers leak to the media information about an industry-funded research project being conducted at a prestigious university to develop smart drugs known as Eugene Pills that target so-called "intelligence genes" to enhance IQ. The leaked story should state that the university plans to distribute the drug freely among its students to increase the university's competitiveness (®TMark, Inc. 2000b).

®TMark was successful in its pursuit of media attention. Besides its online and art world coverage, *National Public Radio* repeatedly covered ®TMark activities (Karr 2000; Rushkoff 1999). *The New York Times* has reported on their activities (Quart 2007) and *CNN.com* referred to their "denial of service" attacks against eToys.com as grounds for "e-commerce sites to keep their defenses sharp" (Messmer 1999). Most of the informants with whom I spoke, even those who opposed some of ®TMark's tactics, praised the work as thorough and clever. Interviewees frequently cited humor as part of the power of ®TMark. People passed on links and information to friends for its satirical value.

This do-it-yourself art creation is an interesting aspect of tactical media work; it requires some effort on the part of the viewer. It is not a form of photorealism that indicates whether a project is or is not an operative image; instead, the context of the object's deployment determines which rhetorical strategies (photos, drawings, logos) would most likely to convince an audience that it is what it claims to be. The site is effective through the audience first mistaking it

for the real thing, but as the website subverts expectations, upon reflection viewer can see it as effective parody.

In contrast to the Blaschka models, the BLO image appears to be of the object itself. The ®TMark website is the thing itself. It claims to be a corporate website and is, in fact, a website that uses image clues and language like those on business websites but it does not represent a business. Tactical media practitioners appear to be indifferent to whether an actual representation or only an imaginable object exists.

Identity

®TMark and other tactical media projects produce irony by creating the appearance that things are other than they seem. Using technology and carefully crafted identities to make it appear that the organizations they claim to represent as large and sophisticated, tactical media artists martial a variety of techniques for their work. The power of these works is possible in part because of the way these actors present themselves and conceive of the resources available for their work.

Tactical media artists are very aware of ways they can compose their own identities. Self-fashioning is a basic tool of their trade. As their projects often have a performance component, physical appearance is one cue for how the audience should understand the artists. When CAE and Paul Vanouse work with biological materials, they often wear lab coats, though sometimes, as in the case of CAE's "The Cult of the New Eve," a feminist critique of the human genome project, they intentionally do not. Instead, for that work, the artists donned matching red hoodies marked with the Cult's symbol.

In some cases, the artists even talk about their self-fashioning. The Yes Men documentary spends significant time showing the preparations required for Servin to pose as a WTO representative. This involves wearing a suit, getting a haircut, and buying a knock-off Rolex watch. Given that costuming is a part of their everyday world and flexible identities seen as a component of their work, we need to look beyond the surface markers to investigate the ways tactical media artists think about their identities and the identity of their social group. Tactical media artists actively construct their identities. This self-fashioning includes maintaining a mythology that is a history of selected influences identified by its artists.

Mythology of Tactical Media

Tactical media artists have a variety of ways of talking about their history, which I will refer as "mythology" in order to designate the way in which the histories are designed as a tool for reading tactical media work. Howard Becker discusses making a mythology for one's practice in *Art Worlds* (1982), in which he describes the network of art in terms that would be familiar to sociologists of science. According to Becker, artists construct for themselves genealogies and histories of influence that credit their predecessors and suggest a trajectory.

So common is this idea in art that we may expect a kind of feedback loop in which artists, aware of the idea, set out already knowing that their "influences" can be selected and that their work will be read through those influences. Tactical media artists may strategically enroll predecessors as influences to describe the work that they wish to be associated with, to build upon, or even as part of a critique. This myth-making is a prominent rhetorical strategy in tactical media, one that relies

heavily on the materials created by the predecessors claimed as lineage in order to be convincing. The tactical media artists have a variety of stories about the major events and influences on tactical media. Most of my interviewees think of themselves with a specific history, one that includes texts like those of the Situationists (Ball 1987), Michel de Certeau's *The Practice of Everyday Life*, and Terry Southern's absurdist novel *Magic Christian*. As these texts are the most often noted by tactical media practitioners are important for their work, I will attempt to offer a sense of each of them and its connection to tactical media.

Situationists

The Situationists formed a political and art movement, based on leftist principles, which was founded in 1957 and dissolved in 1972. Situationist activities included actions in "everyday" society and, beginning in June 1958, the publication of the *Internationale Situationiste*. Members of the movement were associated with European art circles, and sought to facilitate labor strikes. The group's publications and actions may be considered public art since they were political critiques inspired by the avant-garde. The group was interested in setting up situations to fulfill desire ("each person must seek what he loves"), and in order to offer an alternative to capitalism. This interest in setting up the proper environment, or situation, gave the group its name. Tactical media draws some of its character from the Situationist movement, including its interest in intervening in everyday life and its tendency toward the playful.

Guy Debord wrote some of the most recognized Situationist texts, including *Society of the Spectacle*. Debord, as translated by Ken Knabb as part of his Bureau of

Public Secrets (www.bopsecrets.org), begins with the proclamation that "Everything that was directly lived has receded into a representation" (Debord and Knabb 2003). In some respects, ®TMark can be seen as an example of the Situationist concept of détournement—that is, a variation on a previous work that comes to mean the opposite of the original—since it began with the original genre of the corporate website but as it is experienced demonstrates quite the opposite impulses.

The Practice of Everyday Life

Michel de Certeau in *The Practice of Everyday Life* (1984) carefully distinguishes the strategic from the tactical. Strategic maneuvers can be thought of as official and approved actions brought about by institutions; tactical behaviors are those behaviors available to individuals to deflect strategies. De Certeau proposes that tactical behaviors cannot be fully known, but that social sciences should at least attempt to understand what can be known about them. Importantly, in his conception of these two types of behavior, the tactical does not actually try to destroy the strategic. Instead it seeks to empower the less powerful and make the place of the everyman in society "habitable." Garcia and Lovink write that tactical media has drawn the "tactical" in its name from this concept. Tactical media practitioners try to increase the number of tactical actions taken, particularly against corporations (Garcia and Lovink 1997). In this model, the power of tactical media is thought to derive in part from its diffuse nature, though CAE has written that capitalist institutions have become equally diffuse.

The Magic Christian

Southern's *The Magic Christian* (1959) follows the adventures of Guy Grand, a wealthy and colorful character who is continually creating elaborate pranks targeted at everyone from train food vendors to the entertainment and advertising industries. While Grand is not an always sympathetic hero, his jokes reveal others' greed and self-interest. ®TMark's creators were so interested in Southern's novel that they asked his son, Nile Southern, a writer and filmmaker, to act as a "fund manager" for The Magic Christian fund, which suggests such projects as creating pornographic annual reports for a major company (Proctor and Gamble or Time Warner are suggested) with charts "utilizing various body parts as indicators" and mailing them to stockholders (®TMark, Inc. 2000b).

Tactical media artists draw on these works both rhetorically, as standing in for their history and connecting them to a larger body of activism, and specifically, by drawing ideas from them. For example, in Southern's novel, Guy Grand engages in a variety of subversive and often hilarious interventions. The wealthy entrepreneur pays a soap opera actor to deviate from the script, comment on the poor quality of the program, and walk off the set. This spawns the same action by other actors until the show is actually a success because the audience is enraptured by the deviation from the genre. This type of intervention and in particular the copycat syndrome that follows is surely the holy grail of tactical media: the possibility that the interventionist act will result in waves of change.

As Stephen Wilson explains in *Art + Science* (2010), it is impossible to separate contemporary art practice aimed at political outcomes from the happenings and perfoamnce art of the previous five decades. While none of the

artists I spoke with specifically evoked puppeteer protestors or the theatrical actions of Greenpeace, these types of interventions are implicitly available as resources for tactical media artists. The activities of the Yippies and related social theater groups, as well as publications like Abbie Hoffman's *Steal This Book* (1971), were part of the cultural scene from which tactical media emerged.

Like those whom they count as predecessors, tactical media artists weigh in on the side of leftist politics. I asked several of my interviewees if there are any conservative tactical media projects. Surprisingly, two interviewees suggested with irony the same pair of examples: President Bush's strategist Karl Rove and FOX News. These informants were implying that the tactics of pretending to offer imaginary facts were employed with less irony by public figures and news outlets for their political purposes. Another suggested that some of the work of anti-abortion advocates has also taken the form of tactical media projects. Rove's work may not quite approach the work of Donald Segretti (though Rove has been described as his protégé), who after executing a series of "dirty tricks" during the 1972 Nixon campaign went to jail as a Watergate conspirator. However, Rove's work seems to have incorporated some ideas from the "dirty tricks" mentality: that in politics the ends of winning are often worth the means (Bromwich 2010). Tactical media practitioners use tactics that Segretti and Rove would surely recognize.

For many tactical media artists, evoking the history of the Situationists and Southern's novel helps to project the philosophies and histories tactical media artists want to be associated with. The material presence of those works combined with practitioners interest in avant-garde arts allows tactical media artists to make

the case that their work has a political lineage, despite individual actors' backgrounds in art or use of scientific skills.

Mixing Fiction

Many tactical media artists draw on fictional resources as part of their practice. Not dissimilar from creating personas to further a project, fiction and nonfiction are considered resources to be drawn upon for the work. For the science studies analyst this is an unusual situation since most science, and in fact most of the subjects science studies focuses on, may take in constructions and the fictional, but they do so either unknowingly or as part of a construction that is believed to be true, at least by the actors. Intentional deceit and false findings in science are not uncommon, but those claims are generally considered to have been presented as realistic to the audience. For the tactical media artist, however, definitions of the real are complicated. For the creators of BLO, for example, the issues around gender are so real and pressing that whether or not Barbie voice boxes were switched for GI Joe voices boxes becomes irrelevant to their projects.

This is slightly different from Latour's idea that observation is theory dependent (1987; Hanson 1958). If tactical media actors were asked, they might suggest that the fictions were purported by, for example, large corporations, while the truths were exposed by ®TMark. It is simply that for tactical media artists this difference is inconsequential to the goals of their project. They see useful elements in both of these categories and are happy to employ either. Their difference in beliefs affects their observation, not so much through the blurring of fact and fiction

as through the expanse of resources drawn from fiction and nonfiction; sources which they see as equally available to enact their projects.

Material Practices

Now that we have a sense of a few tactical media projects, we can analyze the ways tactical media artists shape the objects they work on and the context the objects inhabit, and in the process undermine any clear division between art and science. This section is divided into two parts: material practices and rhetorical practices. Of course, each of these components builds on the other, reinforcing the power of the project; what an object is materially and what we say it is cannot be separated, but for analytical purposes it is useful to unpack the two. I first treat the material concepts, since they depend directly on what is encoded in some material artifact associated with the project, and not on what is said about the piece. In the next section, I discuss rhetorical strategies which may be to some degree contingent on material object, but are largely about shaping context and the meaning of the object, rather than working directly with materials.

Material Practices

In many cases the scientific work is in the proposition itself. Max Black (1962) differentiates between the mathematically possible and the physically possible in models. As in the theory of natural selection, in some cases the work of science is done by proposing theories, rather than creating physical objects (aside from the text). Conceptual art seems to work in a similar manner. If an artist is able to present an idea without the presence of the embodied object, event, or situation, then does it matter if artists embody these elements for their projects at all? In

short, is it necessary to make things or are ideas enough? These tactical media projects are in some ways similar to planned buildings that are not built. Credit is awarded precisely for the creation of a project whose execution is, in fact, its plans.

Some tactical media artists do create tangible objects while others do not. Many create evidence of objects that did not exist. ®TMark was a website: it was not a corporation in the sense of a group of people who occupy a set of buildings in a business park. It proposed an organizational structure like the structures used by the corporations it attempted to undermine, but it did not exist in a group of cubicles. Its power derived from its clever ideas publicized via its web content and media actions. Is the idea of ®TMark enough? Or is something gained by having the website available to be explored? Other tactical media projects have engaged in information campaigns directed to media outlets. They may have created artifacts like press releases, but the media presentation and subsequent public reaction constitute the execution.

SmartMom (subRosa 2000), a website tactical media project built by the feminist art collective subRosa, consists of a series of pages advertising and explaining a pregnancy suit based on military technology which would enable the surveillance of pregnant women and fetuses. While an actual SmartMom suit was never built, the page includes drawings of the suits and descriptions of usefulness and special features. The entire project is an idea. There is no embodied project, though it might be argued that there is an embodied idea in the form of the descriptive website. The purpose of this project appears to be served simply by releasing the idea that such a surveillance technology could exist. The idea of

thinking of the medical practice of obstetrics in conjunction with surveillance has been researched by Evelyn Fox Keller (1990), Emily Martin (1987), and others. Akrich and Pasveer compared degrees of surveillance during childbirth in the French and Dutch contexts and found that expectations played a major role in the mother's degree of satisfaction with her experience (2000). Whereas surveillance and obstetrics are the subject of subRosa and these science studies scholars' work, their orientation toward critique is different. SmartMom takes these ideas to the extreme, producing a parody, while science studies scholars expose the issues of this way of thinking through detailed accounts of the ways this surveillance techniques work.

®TMark functions on its rhetorical power to suggest that people could alter gas tanks, add characters to video games, or do a host of other activities to draw public attention to political issues, whether or not these projects were ever physically completed as suggested. How far back can this chain extend? Does it even matter whether the ®TMark page existed or would it be enough that the idea of a revolutionary website that appeared to be a corporate webpage was circulated? Marc Bohlen (2007), creator of the tactical media website Real Tech Support (realtechsupport.org) and professor of Media Studies at SUNY Buffalo, is critical of approaches that do not involve, as he puts it "real tangible things." When asked about trends in tactical media, Bohlen argued that people are more likely to respond to projects that involve embodied technologies. "I imagine that people will want more in the future; more […] real tangible things and obvious change" (2007). Bohlen was concerned that media frenzies around ®TMark would not equate to an

actual changes in politics, capitalism, or everyday life. One way to interpret this lack of tangible change is to think of ®TMark's work as a demonstration rather than a change itself.

Nile Southern, a "mutual fund manager" for ®TMark, echoes Bohlen's sentiment that actual social change should be the future goal of tactical media projects. In describing the type of projects he saw as the future for tactical media and ®TMark, he talked about the possibility of enrolling actors already installed in positions of power to do the kinds of things described in ®TMark mutual fund pages. Southern believes that one aspect of a great tactical media project is to produce concrete change in the world: "I guess the really great project for ®TMark would be the one where, and I don't know if they could ever recover from this, […] some people who really are in power to do the kinds of things they do" (2007).

Another aspect of embodiment pertains to the images that are created as part of the press releases for these projects. In fact, for some of the projects the only embodiments are the images or texts created to describe them. For example, the famous Barbie Liberation Organization (BLO) created an image of a GI Joe (Figure 3.1) apparently being reconfigured. The image circulated widely on the internet along with various texts describing the project. It is now largely believed that no Barbies or GI Joes were, in fact, ever tampered with. One bit of evidence for this is the absurd latex gloves the posed G.I. Joe surgeon is wearing. They seem to suggest a medical context for the voicebox alterations and are, therefore, humorous when we consider that the surgery is on a plastic doll. The image purports to document an event that never happened to enable an artwork to occur through public

engagement. The project's idea propagated through the media as fact through a series of elaborate press releases that effectively created a public art project. The image was created as evidence for the claim that such a project had been executed. But since there was no final product, the images become the artwork itself.

Figure 3.1. Barbie Liberation Organization operates on a G.I. Joe (sniggle.net 2007)

Norbert Wiener in his seminal text, *God and Golem Inc.* (1964), introduced the concept of operative images. Describing machine reproduction, Wiener distinguished the idea of a pictorial image from what he calls an "operative image." While pictorial images represent the original form, operative images perform the same functions as the original. We may think of examples of operative images from science in regard to things we can never actually see with our eyes. For example, images of nanoscale phenomena can be thought of as operative images since they depict what scientists believe are the fundamental aspects of what they are studying. This is evidenced by the fact that scientists study these images as data, as opposed to using them, as they do in other contexts, for illustration or evidence.

These images are operative in the sense that they actually are the work that is done in nanotechnology research.

In the case of the BLO project, the GI Joe image is central to its power to capture interest. In the GI Joe image above, the function of the original is being carried out by the image. In the absence of the original—that is an actual altered doll—the image carries out its intended function: to spread an idea about gender and children's technologies. Thus, the image of the GI Joe is an operative image: it performs the function of the technology. It makes the viewer aware of an argument that this imaginary toy technology is making for a certain view of gender by contradicting our everyday expectation of what the toy soldier should say. Interestingly, however, like a depiction of a unicorn or an ascending saint, the image depicts an original that never existed. This differs from the case of the SmartMom suit, in which the image at most depicts a drawing that could be thought of as a mock-up for the potential suit. By contrast, the BLO image appears to be of the object itself. The ®TMark website is the thing itself. It claims to be a corporate website and is, in fact, a website that uses image clues and language like those on business websites.

While we may not know, for example, if BLO physically tampered with Barbie dolls, we may suspect from the range of possible activities of tactical media artists that the project revolves around the media rather than the object. BLO depicts something that seems possible, and indeed this thought experiment element of the project is part of its power. The potential disappointment which viewers may feel upon learning how tactical media works is a complex emotion. It is hard to diagnose

whether this feeling is the loss viewers feel about being duped or a disappointment related to a wish that these ideas become material. In any case, these feelings are somewhat inverted in the reactions of many of BLO's peers who feel that the art is all the more brilliant because it exists as an idea and a material paper trail rather than as the object itself.

There are many applicable science studies theories for exploring this type of tactical media project. Latour might find this form of immutable mobile disconcerting, since he does not envision explorers who bring home inaccurate maps to make political points (1987). Yet this is a false testimony, a lying virtual witness (Shapin and Schaffer 1985). Some tactical media images do portray actual objects as they are, so they can be easily confused with the status of other images that act as apparent proof of the construction of a technology that never existed. Instead, these images are calculated to produce an effect in the viewer. It is not photorealism that indicates whether a project is or is not an operative image, but rather the context of the object's deployment which determines what rhetorical strategies (photos, drawings, and logos) would be most likely to convince an audience that something is what it claims to be.

Herein lies one difference between how the tactical media network and the scientific network assess the validity of projects. BLO was greeted as a major success among tactical media artists, while evidence for building a technology that does not exist in science is considered not only invalid but potentially an ethical problem. If a robotics laboratory that is trying to produce a flying robot attaches fishing line to make the robot float in order to give an idea about how this might be

done, the image of the floating robot will not constitute proof of the invention of a new technology once the strings are discovered. BLO on the other hand was heralded all the more for its success at producing a political idea in the mind of viewers by using only images.

The Technical in Tactical Media

The use of technical materials and related expertise is an important way that tactical media artists gain credibility, both in their community and with the public who views their projects. While some technical skills can be fudged, like the BLO's images, which did not require artists to actually create dolls that worked to get their point across, many projects do require technical skills and these skills cover a range of types of expertise. These projects are often designed to comment on the technology they are working with; for example, Shepard's project shows what a community might do with control of GPS technology. Many engage in important debates in the scientific field that touch on public knowledge; in OneTree(s) Jeremijenko is offering an experiment that raises questions about the nature/nurture debate, based on her knowledge of botanical cloning.

Rhetorical Practices

Rhetorical practices designate elements of tactical media projects which are not directly material. The difference between material and theoretical resources is not a clean break, but rather a way to separate out two types of important strategies tactical media artists use. Rhetorical strategies often do involve material aspects, but they are not entirely dependent on them. The rhetorical elements give the objects tactical media artists work with specific meanings. I address several common

rhetorical strategies with an eye to understanding how they are employed on specific projects and why their users believe them to be useful.

Characters

Goffman's theories (1959) on identity performance can offer some direction in understanding presentations of self available to interviewers in various contexts: "…when an individual appears before others he will have many motives for trying to control the impression they receive of the situation. … The issues dealt with by stage craft and stage management are sometimes trivial but they are quite general; they seem to occur everywhere in social life" (24). Goffman's observations bear on both interviews and the creation of personas. These sometimes fictionalized identities are created in order to designate the intentionality involved in identity performance. While Goffman has shown us that some of this behavior is always in play in self-presentation, tactical media artists sometimes create identities intentionally for the purpose of a tactical media project. I call these identities "characters" to signal that these exist in the context of the project.

For some tactical media artists, the idea of performing identity is made explicit: they are literarily performing the identities of others through all available means. This may be done to appear to be expert on a topic or to belong to a particular social group—either artists or scientists. In the most extreme version, the performance may involve mimicking a persona associated with a specific group or even a specific individual. The identity mimicry is sometimes as simple as giving a false name, but may be as subtle as a clothing choice. This has the effect of unwinding categories and undermining what these artists might see as the too easy

boxing of people. In either case, a combination of rhetorical devices and material objects suggest and then support the idea that the person in question is a specific character. For example, in order to locate a speaker for a conference, an organization might approach one of the Yes Men's spoof websites. The Yes Men deploy their website as evidence of the validity of their claim to belong to a specified organization. The authority that the website provides allows the artist to respond on his own terms and in his own framing language to journalists' inquiries.

Authenticity is always an issue for the interviewer, and the internet poses some specific challenges. Christine Hine (2000) has explored the issue of authenticity on the internet. She pointed out that in the internet context, different markers may be used to judge authenticity. Some may have a clear correspondence to the traditional interview setting, while others are specific to online presence. As Sherry Turkle (1997) has explained, our interactions with computers are no longer about giving machines commands but now deal with relationships.The internet may be viewed as an identity play-space, and experiments with identity are frequently welcomed by groups of users. Hine proposes that, instead of inquiring about whether persons known via the internet are who they claim to be, or attempting to judge whether or not internet presence mirrors or even maps offline identities, ethnographers should focus on how internet culture is known and organized on its own terms.

One of the more interesting situations I encountered was an interviewee who spoke to me about interactions with a person whom I knew to be a character created by ®TMark. Pretending to be someone else or connected to a group that you

portray as larger or more important than it is for performance effect is an important tactical media strategy, but the degree to which this individual understood the person being discussed as an invention of tactical media or an actual person involved in the projects of ®TMark was never clear.

If we take the actions of these informants as a version of Goffman's observations about maintaining a public persona, we can understand that performing a different identity in different contexts is similar to creating an entirely distinct persona in each. In the case of ®TMark, additional characters, for example a CEO, add legitimacy to the project's claim that the organization acts as a corporate entity. Even more frequent in my interviews was a sort of passive allowing of misinformation. Interviewees did not directly participate in but enabled the potential belief of the listener in the claims of a fictive person or confirmed parts of stories about ®TMark. This was signaled by phrases like "a person who called himself" or "the person you are calling" or even "a person who goes by" or "a person who is called." These were ways I was made aware and could respond about relevant actors without directly exposing their knowledge of a particular actor's fictive identity.

Goffman's 1952 "On Cooling the Mark Out" addresses the feeling some will have when faced with facts that do not quite add up. While some projects that involve deceit are meant to come to a clear end where everyone is made aware of the "con," often the marks of these projects realize they have been had before the announcement of the con, and may for their own reasons lead others along into the ploy. Such was the case for one journalist I spoke to, who confessed to not making

apparent to the public what he suspected, since he liked the game the tactical media artists were playing and, further, was sympathetic to their political cause. Instead of needing the "operator" to console them for their the error thinking, these "marks" join the cause, in a situation analogous to Stockholm Syndrome, in which those who might have been victims of the ploy feel themselves to have become insiders, capable of assisting in the cause they were once set to experience as outsiders. Although affordances of technological communication created as part of a strategy on the part of the interviewee, may be nothing new in Goffman's terms, they certainly put the interviewer at an information disadvantage.

In another example, the Yes Men have become famous for what they call "identity corrections." In these situations, tactical media artists pose in public as representatives of institutions or as people who they are not, in order to say things that they believe reflect the true sentiments of the people they depict, things that those individuals would never say directly. Michael Lynch (2009) has suggested that perhaps what they are doing is working with "inadmissible truths" (Personal communication 2009These truths might be suggested through fictionalized means. For example, the Yes Men gave a series of lectures at conferences posing as representatives of the WTO, in which they suggested outlandish schemes that were hardly noticed by listeners. On one occasion their presentation included a demonstration of a leisure suit for promoting worker productivity. The suit could open to unfurl a large metallic phallus with a screen for tracking workers. These identity-correcting actions may be seen as similar to websites supported and promoted by ®TMark, like gwbush.com, an ®TMark website that appeared to be a

campaign website but which was critical of the candidate, often through his own words. Much to the artists' delight, as for them all press is art, Bush campaign's lawyers eventually sent a cease-and-desist letter, which ®TMark posted on their website.

Individuals wishing to appear to be other people, or in some case a large group or institution, benefit from affordances, like technological communication devices that can mask the individual. As one informant, Paul Vanouse, put it: "That was the thing about the internet and earlier technologies like the telephone; you never quite knew what you were dealing with… The amazing thing about ®TMark was the kind of authority they managed to have, even though it was just run by a few people" (Vanouse 2007). Adding additional phone lines, which run to a single office, or having additional web pages can give the impression of an expansive project. This strategy may be somewhat more common than it might appear.[1] A combination of rhetorical misdirection and materials offered to bolster the credibility of such misdirection made ®TMark's success possible.

The Role of Humor

From the idea of pigeons wearing air pollution sensor backpacks to the Yes Men offering New York Times editions announcing the end of the Iraq War, a combination of critique and humor are present in practically every TM project. The humor hinges on making specific claims for the role of a material object, and so, in the levity of tactical media projects, we again find the mixing of the rhetorical and

1 Manjari Mahajan has pointed out that she encountered a similar phenomenon with a non-governmental organization in India which opposed GMOs and which turned out to be a single resourceful activist.

material to produce the artists' desired effects. It is also notable that the pleasure a viewer takes in the project is, at least in some cases, shared by the tactical media artist. In a revealing moment in their documentary, the Yes Men say that performing identity correction that involved humor through overstating the position of those they were impersonating, and was simply "more fun" than offering new "correct" directions for institutions to take.

One of the most striking elements of tactical media is how these projects work as insider artifacts, while also being palatable as pop news blurbs. A major goal of tactical media is for their projects to be spread through the press, internet communication, or word-of-mouth. This act of transferring the project is complicated; however, since often a great deal of context is necessary to understand the full meaning of a project. The result is a split between types of audiences. The public views and reacts to the primary release of the website, story, or project, while a secondary audience views the primary materials and watches the primary audience as part of the artwork.

Without the context of tactical media and the expectation that part of the art takes place in the public reaction to it, some projects are not immediately interpretable, despite their claims to be reaching out to a broader audience. For example, the ®TMark web page performs as we expect a company website to act—as an advertisement hailing the possibility for profits and benefits from efficiencies made possible by ®TMark. However, the viewer soon realizes that there is something else beneath the smooth exterior of the page. If you visit the website, and the satire is not immediately obvious to you, you are in good company. Like those

who believed they were witnessing an invasion while hearing Orson Welles' radio broadcast (Wells 1938) or audiences quickly flipping past the Daily Show or Onion News Network and mistaking these shows for traditional news programming, these artworks are not always obvious from the outset. This non-obviousness is part of their captivating power: giving artists more time to transfer their political points, though the degree of the suspension of disbelief is sometimes a surprise to the artists themselves. To fully appreciate the work of ®TMark or BLO it is necessary to also consider the impact these projects had in the press and social networks, as items about each were circulated.

In becoming part of this secondary audience, I found that most of my informants who were not directly involved with the project did not simply stumble upon this site on the web. Instead their experiences were preceded by suggestions that the ®TMark was a tactical media project. While some interviewees did understand the project right away, every informant I talked to found the website through their social networks, as opposed to online searches linking them to the site. Most found out about the project through friends and colleagues. Some were even introduced to the project as an exemplar in art school. These contexts provided by social connections make sense of the ®TMark page. It is, in fact, this insider knowledge of how to understand the mimicry which leads to the dry and intellectual humor that much of the ®TMark site provokes. The hook of this work is the humor and irony that allows an individual to experience this political critique, thereby accessing this social group's mode of communication and way of awarding value. The basic politics of the critique are apparent, but it is the method of the critique

that enthralls the audience and promotes a sense of community among tactical media artists.

Using Versus Critiquing

The way that tactical media artists talk and write about their projects creates a tension between the use of science and technology in their projects and the critiques of science and technology that these projects engage in. Mark Shepard's "Tactical Sound Garden," described above, is an example. In a 2007 interview, Shepard talked about how he evaluates his projects that involve public participation using criteria drawn from evaluative practices in science. Shepard is concerned that his projects should "work" in a technical sense. Yet this project also challenges the way GPS technologies have been developed and how those technologies might be used differently if placed in the hands of community members.

Evaluative practices force us to consider how the creators and performers of a project know that the project has "worked." The failure or success of a tactical media project seems to occur at an epistemic level that is rather different from how scientists determine whether an experiment or technology has worked, but the two settings may share some elements. Moreover, various tactical media projects happen on very different registers with regard to this issue. For example, the standard used to determine that ®TMark was successful had to do with public outreach, while Singer's AIR project's success was in part dependent on technical success, a criterion which would be more familiar to scientists.

Later in the interview Shepard talked about the disparities in acceptance by others, particularly academic communities, depending on whether the artist chooses or does not choose to use evaluative techniques. He suggested that artists are more interested in why those techniques make a project more acceptable. "Another problem is the borrowing of evaluation. […] We can measure certain parameters of interaction in these projects. I think artists aren't interested in the acceptance of particular techniques…. It's more about thinking about the acceptance disparities" (Shepard 2007).

Brooke Singer, co-creator of AIR, faced the tension between wanting to make sure her air sensors offered reliable air pollution readings and wanting to critique the way such readings are taken in standard scientific practice. This tension between the scientific standard and what she and her colleagues viewed as the best practice comes to a head over the issue of sensor movement: "With AIR there has been a question about whether the results are scientific […] We are moving these things around and the scientific standard is that they stay in place with these things for a long time and do it over and over and over again and take the average reading… but there are things our research does really well, like if a person wants to see it [their air pollution exposure] on their daily commute, then we can start looking at the usefulness for these mobile sensors" (Singer 2007).

This issue of evaluation and what counts as participant in scientific discourse remains difficult. In order to launch a critique of science that scientists will consider valid and which the public will accept as scientific, artists often have to participate in many components of the scientific method (like evaluation) themselves. Artists'

commitments to using some techniques that are labeled as scientific can undermine their ability to make certain criticisms. This circularity of knowledge and permission to participate in scientific discourse or even present ideas to be taken seriously by the scientific community is certainly nothing new to science studies. Epstein (1996) showed that AIDS activists had to gain proficiency with medical language in order to participate in the scientific discussion, and thereby influence the scientific process. Like AIDS activists, tactical media artists do not want to become scientists. Tactical media artists do engage and learn from scientists but generally they attempt to exact change by communicating with lay audiences. This is in contrast to AIDS activists attempts to change a specific scientific practice, clinical drug trial protocols. Rather, to participate in the scientific discussion and deploy close critiques, these artists master many scientific protocols so that they become to some extent enrolled in the scientific process themselves.

Agency of Technology

Tactical media artists believe that by changing technology they can change society. This commits them to two positions: 1) technology shapes society; and 2) the trajectory is not set in stone (even if it is a bit rigid and hard to change). This philosophy plays out differently in different people's work and even between an individual's different projects. For many of these actors, technology is a cultural artifact of society, enabled by any group of individuals who are willing to act. While this group of actors perceives institutional entities, like corporations and the military, as able and constantly engaged in attempts to control technologies, they are also at once convinced that if large institutions can have an impact on the way

technologies are read and used, then smaller groups of actors (like themselves) can also shape technologies and thereby offer new possibilities for society.

Tactical media artists attempt to offer other patterns of technology; they maintain that their projects offer new social meanings that can alter society. An STS scholar might claim that this dual position of insisting on the consequences of technology and also on its malleability forces these artists to live in a fragmented world, one in which they are both determinist and constructivist (Smith and Marx 1994). Yet despite the fact that tactical media artists are aware of both of these positions, the contradiction is largely absent in tactical media itself. To these actors there is no conflict. For the artists of tactical media, separating technology and society is all but moot, as technology is treated as material culture that, like art, can be shaped to perform a variety of roles in society.

To put this in terms of actor-network theory, we can think of the technologies built by tactical media artists as actants. They are activated by the social meanings ascribed to them by the community. Like Callon's scallops, da Costa's pigeons provide both means and resistance to human's intended projects (Callon 1986; da Costa 2006). This way of framing tactical media is useful because it helps to convey the idea that while it is up to artists to activate the social meanings of their actants, their projects have affordances and resistances that are sometimes predictable but sometimes totally unknown to the artists until the object or project has been put into play. Like failed experiments, there are likely many failed tactical media attempts simply go on without note.

Like experimental scientists, tactical media artists may have hypotheses for the outcomes of their works, but they can never know for sure what the outcome will be. The concept of trajectory in technological determinism is undermined by the actors' explicit knowledge that they cannot know how their projects will turn out in terms of the assemblage of technical components or in the way they will be interpreted. For example, in their documentary, the Yes Men emphasize that they did not know what would happen when they initially engaged in identity correction by posing as WTO figures. They eventually became used to having their outrageous claims all but ignored by audiences and began to wonder exactly how far they could push the envelope without a response. Through repeated action, they are able to make guesses about the potential audience reactions, but they are never able to fully predict how their work will be perceived.

Some tactical media artists contend that it is important for them to believe in the possibilities for their new creations. Jeremijenko identifies her projects, like OneTree(s), as different from what is available in the mainstream, thereby demonstrating that technologies are not inevitabilities. "[My projects] did not emerge from the corporate imagination, and therefore showed that the mainstream corporate technologies were neither comprehensive, nor inevitable, and perhaps not even desirable." (Jeremijenko 2007)

Alternatively, there is a commitment to the idea that technologies lead to outcomes: that is, after all, precisely the power in reformulating them. Paul Vanouse, creator of several projects critiquing connections between the biological sciences and the corporate world, was very familiar with the science studies positions on

determinism. When I edged toward asking him if there was a belief in the tactical media community that social and technological conditions made the ®TMark project work possible only in the particular moment of expansion of the World Wide Web in the early 1990s, he beat me to my concern: "Not to be technologically determinist, but I think the way they approached setting up that company was possible to do really well at that time... At that time, the tools to develop the web were not very expensive" (Vanouse 2007).

According to Hine: "People's beliefs about the internet may have important consequences for the ways people related to the technology and one another through it" (2000, 8). Perhaps Vanouse's idea that there was a historical moment in which a project like ®TMark could come together can be understood through Hine's view to mean that potential projects emerged from people's beliefs about what was possible on the internet at that time. Once closure is reached around the possible uses for a technology like the internet or, in ®TMark's case, the corporate website, the possibilities for change and subversion become limited (Pinch and Bijker 1984). As Vanouse pointed out, the threshold for appearing to be a corporate website, in terms of the degree of sophistication required (the inclusion of complex video and graphic content), has increased dramatically since the time of ®TMark; the brief window during which tactical media artists' projects could plausibly appear to be a corporation has closed. On a deeper level, ideas about how the internet might be revolutionary changed. This could be seen as a sort of social determinism, in which the kind of change tactical media artists hope to create is limited by the ways people conceive of the possibilities for technologies. However, it is just as sensible to take

tactical media artists' belief that technology, like art, is a product of and intertwined with society, rather than as a separate potentially determined and determining part of society.

Conclusion

Science studies scholars will want to consider how often the very points we might be inclined to make about the nature of technology or the interaction between technology, expertise, and institutional power are present in art work—if not explicitly, then by other means. Like science studies, many science-engaged artworks are dependent on the details of science and on a reflexive understanding of science to produce critiques. In "Silence in Context" (1999), Michael Lynch writes about a concept called "ethnomethodological ground zero," an imagined place where nothing is left of ethnomethodology's methods precisely because they originate from other sources. Instead of a set of methods or a central theory, Lynch proposes that ethnomethodologists share an "attitude."

This attitude, according to Lynch, is one of "indifference" (1999). Similarly, much STS scholarship does not set out to value the actions of others or offer policy recommendations on how a matter might be improved or worsened. While not always the case, tactical media artists are, in general, concerned with such outcomes. The very point of their projects is to forward a political agenda. The particulars of the project are part of the vehicle for carrying those agendas forward by making them attractive to media outlets. They are designed to encourage attention and audiences discussion about related issues.

What is at stake in a tactical media project is, of course, dependent on what the project is and who is involved. Since many tactical media projects involve group work, the motivations and intentions of a project may be obscured—if they were ever clear to any one artist in the first place. These projects are created in order to critique power structures, including corporate control and the scientific method. The blurring of art and science is often not the point but a side effect of the political agendas of the artists.

Tactical media artists are conscious of the rhetorical power of the concepts "art" and "science." In their practice, they use this knowledge to reshape and recast projects as artistic or scientific, depending on their needs. Natalie Jeremijenko, tactical media artist and creator of the "Feral Robotic Dog" project, makes this point exceptionally clear when she says, "I avoid the term [artist], except when it is tactical."

Scientists, in Gieryn's (1983) account, try to build up a barrier between other ways of knowing and the scientific way of knowing. Tactical media artists pull that barrier down by conducting research and creating projects that contain elements of both science and art. These categories are held as very easily distinguishable or even opposites by some scientists, artists, and others. Tactical media projects – for example, the Feral Robotic Dogs – violate the supposed differences between these two communities by using each community's labeling system to gain project acceptance. Jeremijenko's comment concerns leveraging the language of art and science for a purpose, rather than in an attempt to recalibrate objects so that they

can be useful in different ways to different communities. She is building objects for her own purposes and then employing language to emphasize their affordances.

This sentiment was clarified further during an interview with Igor Vamos (2007), one of the founders of ®TMark:

> HR: Does it matter to you whether people see this project as politics or art or technological…?
>
> IV: No, whatever it takes for them to listen to the stories.

Vamos is once again asserting the idea that in tactical media the primary concern is telling stories. His attitude toward my list of potential labels for this work was indifference. What mattered to Vamos was getting across a narrative, the label being use to describe the work was simply a tool for encouraging people to listen. The format, tactical media, may be incidental. The format is likely as related to Vanouse's career as an academic and "emerging media" artist as to the particulars of his political messages. Like academics collecting papers to create viable careers, academic artists must maintain connections in the art world and produce artworks relevant to the interests of their affiliated departments. As Latour (1986) has suggested, our best options for moving forward in the study of the visual are to look at the goals of visual production. In tactical media worlds, words like art, science, technological, and political have explicitly become rhetorical devices for furthering artists' agendas.

CHAPTER 4: SYMBIOTICA: CULTURING ART AND SCIENCE

Introduction

SymbioticA is a research laboratory that brings together artists and scientists for collaborative wetlab work. This established bioart community is dedicated to exploring biological technologies and scientific knowledge from an artistic perspective. Located in the School of Human Anatomy and Biology at the University of Western Australia (UWA), SymbioticA is a collection experts and equipment and stable access to institutional passage points, such as ethics review boards and funding. A myriad of people circulate through the facility, bringing their own ideas and techniques and participating in structured activities, such as weekly meetings and laboratory protocol training. As the first artistic research laboratory of its kind, it has served as a model for other similar ventures, including the Bioart Initiative at Rensselaer Polytechnic Institute which was founded by former SymbioticA residents. Several art-science collaborations, including the Swiss institute Artists in Labs (AIL) in Zurich, Switzerland, and Le Laboratoire in Paris, France, have emerged in the last decade, but SymbioticA is unique in functioning as a wet biology lab in a research university.

The University of Western Australia is a major research institution in Australia, a member of the prestigious Group of Eight. SymbioticA's physical spaces include a top-floor studio that was initially created by the architect of the Human Anatomy building to be a space for artists; its design reveals his preconceptions about what kinds of work artists working with scientific materials would be doing. The architect emphasized the excellent natural light that the ceiling windows

provided, but the room did not contain the tissue culture equipment SymbioticA needed. The artists converted the studio to office and meeting space and borrowed lab space. As of 2009, SymbioticA had one lab entirely to itself and several shared lab spaces, including shared space in the animal research facility and in the spectroscopy laboratory. The practice of sharing space is typical of all of the research groups at the School of Anatomy and Human Biology.

SymbioticA originated from the work of a group of bioartists—Ionat Zurr, Oron Catts, and Guy Ben-Ary, initially known as Tissue Culture & Art (TC&A)—who continue to display as a group and as SymbioticA researchers. Miranda Grounds, a cell biologist at UWA, took an interest in the vision these artists promoted, and helped them gain access to biological laboratories and scientific expertise. SymbioticA, formally founded in 2000 by Grounds, neurologist Stuart Bunt, and Oron Catts, and has grown in scope and size to encompass TC&A and SymbioticA research activities, and supporting visiting artists (known at SymbioticA as 'residents'), sponsoring arts programs, and hosting meetings between scientists and artists. Manager Jane Coakley conducts SymbioticA's fundraising and oversees the residents.

The membership of the groups that work on formal and informal bioart projects is frequently in flux. During its nearly ten-year history, SymbioticA has hosted more than 60 full-time resident researchers. They have ranged from well-known artists who had already worked with biological materials, such as Paul Vanouse, Stelarc, Steve Kurtz, Paul Thomas, Orlan, and Adam Zaretsky, to curious students, new to working with scientific materials. Residents and researchers work

in the University of Western Australia's laboratory spaces, and in what SymbioticA director Oron Catts calls "a half-way house," an art space housed in the School of Anatomy building. SymbioticA researchers may work in concert with one another or on their own solo projects. The academic co-coordinator, Professor Ionat Zurr, facilitates courses for undergraduates on "life manipulation" and the relationship between science and art in bioarts, and runs a small graduate program that offers artists a chance to take biology courses and biologists an opportunity to take art courses.

Bioart

Bioart is a contested category (Britton and Collins 2003; Smith and Clarke 2005; Munster 2006; Kac 2006; da Costa and Philip 2008). Catts and Zurr reject the term "bioart," claiming that we should "maintain the integrity of the disciplines," a potentially fraught statement for artists located in the School of Human Anatomy and Biology. These actors see themselves as artists practicing in the sciences rather than as hybrid artist-scientists. Instead, they identify their work as "biological arts"—a rather fine distinction. But in an art world captivated by theory, where almost every work engages both scientific and artistic themes, it may not be surprising that the categories in which artists place themselves and their works are minced into micro-distinctions. It is worth noting that tactical media and bioarts have some overlapping influences and artists. Both movements position themselves in relation to new media and emphasize critiques of science and technology. However, their networks are largely distinct (with the exception of a few artists, including Beatriz da Costa and Paul Vanouse) and the focus of their works is

different. Tactical media works are more likely to emphasize a broader range of critiques of political authority and power, while bioarts are more likely to concentrate on critiques of science and scientific power.

The tradition of schools of art and art movements gives ample incentive for actors to engage in self-classification. The formation of art factions is part of the process of self-fashioning, of becoming an artist, and it is through these groups that credit is often awarded. In the tradition of art, these actors are trying to orient themselves in relation to other art movements, but there are other influences as well, including scientific communities, and a concern for the political impact of bioart. Bioart and tactical media are social movements. Despite the fact that bioart is frequently on display in art museums, so-called "high" art networks remain uninterested in bioart. And indeed bioartists appear to be uninterested in modifying their production to suit these parts of the art network. The struggle over how bioart will be defined involves not only choices about self-description, but also the formation of networks of people and materials to support projects and decisions about where to show artwork and where to seek funding.

The term "bioart" was coined by Eduardo Kac as a description of his 1997 "Time Capsule," which involved the implantation of an identification microchip into his leg (Britton and Collins 2003). Definitions of bioart range from the very general (anything displayed as art that combines biology and art, such as photographs of cells) to a narrow concept that specifies a set of practices, which includes using biotechnological techniques to critique modern biology. An example is Tissue Culture & Art's project "Disembodied Cuisine" (2001), in which cultured frog tissue

is presented as meat as a way to critique the idea of tissue culture as a technique for creating meat without killing animals. There is considerable border policing among bioartists, which centers on valuing projects that use biotechnology materials for the purpose of critiquing current developments and foreseeable uses of biological science. This policing behavior is on display in their attitude toward art shows and reviews, which display science-related work that is not critical alongside critical works. Bioartists talk about such exhibitions as sources of confusion for audiences about the point of their work, and they tend to distance themselves from "straight" science artworks. For example, at SymbioticA several researchers poked fun at a science communication prize they had won. They compared it unfavorably with their "real" accolades from the art community. It seems that they believed that the science communication award did not fit their work and that the group which conferred the award understood them in an "un-ironic" way. For these bioartists, public engagement means endowing viewers with a critical eye, as well as access to the skills and materials required for entering scientific discourse, at least at an amateur level, rather than attempting to communicate the value of scientific findings and the possibilities for science-improved futures to the public. Here the bioartists' way of thinking seems to correspond to Collins and Evans' (2002) category of "interactional expertise" – meaning an ability to understand expert knowledge well enough to talk about it in an informed way.

This chapter analyzes three projects in the life of SymbioticA: Pig Wings, victimless leather/meat, and MEART. It is a story of the self-conscious fashioning of a technical and social movement. The practitioners and artists at SymbioticA believe

they are creating works that critique science. They fit their creations into science and art networks by drawing on resources from the world of tissue culture and biological sciences and placing them in art installations.

Method

My research consisted of ethnography at SymbioticA. During course of a trip to Perth for my fieldwork at UWA, as well as other trips to meet the artists and their collaborators at major U. S. art venues, I had the opportunity to interview scientists, artists, university administrators, arts managers, ethics, animal welfare and biosafety advocates, curators, and graduate students associated with SymbioticA, and other comparable labs. I also observed and talked with undergraduate students taking courses at SymbioticA. In addition, I examined with a variety of textual materials, including science publications, lab book notes, tissue culture protocols, artists' statements, funding documents, media coverage, artist blog culture, artist and art institution documentation, curatorial calls for artwork, statements and advertisements, and gallery documents.

I was also able to interview several other residents and former residents who were in the process of leaving SymbioticA when I arrived or had completed projects in the past, and this gave me a sense of how these artists reflected back on their residencies. I attended a workshop for introducing new artists to the work of biological arts. Toward the beginning of my stay in Perth I attended an animal ethics course that turned out to be very interesting, as this is a site of mixing between new or young scientists and students and residents of SymbioticA. I also attended a number of art shows, openings, and gallery displays.

As an ethnographer I had relatively good access to the lifeworld of SymbioticA researchers. In nearly every case, artists and scientists were open and eager to talk with me about their work. SymbioticA, like many groups of contemporary artists, functions in a profoundly co-operative way. Most SymbioticA projects are co-operative affairs that include not only a combination of artists and technicians or scientists but often several people from each of these categories. In short, working on a project at SymbioticA has more in common with the collaborative work we observe in scientific research groups than with our imagined realm of the lonely genius artist. I was able to act as a participant-observer during traditional tissue culture work, including growing tissues over polymers. I primarily observed the projects of two residents at SymbioticA, one working on several projects that involved blood and animals and the other on synthetic biology. It is also worth noting that though science studies scholars may be less than familiar with their work; these actors were generally familiar with the concepts of science studies. This caused some unusual situations, including by some artists expressed interests in learning about my work and science studies more generally, and in using it in their own work. This was similar to the case of tactical media practitioners, who were very informed of science studies issues. Both groups seem to find ways to understand their work in science studies, and this might induce a moment of self-reflexivity in science studies scholars.

Mythology

Artists select their influences and may choose them for many reasons: because of a personal interaction, in light of the tradition of the movement to which

they belong, or, conversely, through a desire to break with tradition or to be provocative. Catts was trained in a school of design and Zurr was trained as a photographer and then art historian, but they both point to Nobel laureate Alexis Carrel, as among their most important influences. Carrel, a Frenchman working at the Rochester Institute of Technology in the 1930s, was a surgeon and eugenicist who created tissue culture techniques and brought them to the forefront of medicine. An art historian might add that for artists to take an interest in science is hardly a new phenomenon. The Romantics (Curran 1993), the Surrealists (Fer, Batchelor and Wood 1993), and the Situationists (Knabb 1981; Ball 1987) all engaged with and critiqued the power of science and technology. The Situationists' connections are particularly interesting because tactical media practitioners also draw from their work.

From the world of art, bioartists point to earlier visionary artists, sometimes known as body artists, like Stelarc (Paffrath and Stelarc 1984; Smith and Morra 2006) and Orlan (O'Bryan 2005; Smith and Morra 2006). Other contemporary bioartists, including Kathy High and Verena Kaminiarz, locate the origins of their work in 1960s projects with animals by artists such as Joseph Beuys. Many others, including Adam Zaretsky (2007) and Amy Youngs (2000), point to a 1936 exhibit by Edward Steichen.

In that year, Edward Steichen (1879-1973) presented delphiniums he had bred as an exhibit in the Museum of Modern Art (MoMA) (Gessert 2010). Steichen was a famous photographer and Director of Photography at the MoMA. Whereas the bloom of a stalk of a typical delphinium might be a few inches to over a foot long,

Steichen's delphiniums were three times that size (See Figure 4.1). The gigantic blooms were produced through selective breeding and mutations. Steichen used the medication colchicine to change the plant's genetic makeup, creating new strains of delphiniums (Gedrim 1993).

Figure 4.1.Edward Steichen's Delphiniums, 1936. Installation view of the exhibition. The Museum of Modern Art, New York (Bulatov 2004).

By claiming Steichen as a forerunner, bioartists tend to emphasize two elements of his approach: his direct intervention into the genetics of the plant and his interest in democratizing art, as exemplified in his plan to sell packs of his seeds cheaply to the public. Steichen's delphiniums are held as one of the earliest examples of the direct manipulation of life specifically for overt political purposes.

Interestingly, however, the origin myth most often circulated at SymbioticA is not the tale of a person whom we would typically think of as an artist. As mentioned above, SymbioticA leaders, particularly Oron Catts and Ionat Zurr, think of a tissue culture scientist as their predecessor when they cite the historical figure

of Alexis Carrel. They have gone to some lengths, including a trip to the Rockefeller Institute for Medical Research, to learn more about him. Carrel developed new techniques for vascular suture and won the 1912 Nobel Prize in medicine and physiology for his work on blood vessel suturing and transplant work on animals. Along with Charles Lindbergh, Carrel was involved in promoting the idea of organ creation and transplant. Bioartists understand Carrel as both a genius and a scholar with problematic and difficult views, even for his time. Such alternative histories of science, a concept familiar to STS audiences, are frequently used when describing Carrel's mixture of important medical contributions and pro-eugenics writings. He was involved with the eugenics movement and wrote a book on the future of society under the control of a small group of educated elite. When he won the 1912 Nobel Prize in Physiology or Medicine, he appeared on the cover of Time magazine, along with Charles Lindbergh. The feature article discussed their work on creating the artificial heart (Friedman 2007; Malinin 1979; Newton 1987; Reggiani 2007).

Carrel ran a strange type of tight ship, including a set of rigid, ritualized rules for his technical staff. He insisted on gray lab coats and believed he had been able to create an immortal cell line from chicken embryos. Controversy has surrounded his experiments, and it is widely believed that his technicians simply replenished cell lines when they stopped dividing. In any case, he never became aware of the limits of cell division (Hayflick 1997; Witkowski 1980). SymbioticA artists see Carrel as both a scientist of his time embroiled in the controversies around the eugenics movement, and a fascinating figure with peculiar habits to be played upon for the sake of artistic interest.

It is notable that these artists choose scientists to populate their history. When we see them enrolling into their network predecessors who legitimate their current practice, surely we are seeing a mode of self-fashioning. Carrel makes sense as a figure of interest for these artists precisely because of his dual character as both scientific contributor and social mad man. He serves as a point of reference for the way that many bioartists see science: as a powerful tool for exposing knowledge and possibilities and yet ripe for critique because of its mistakes and social misuses. The artists are pulling themselves into a particular history of science rather than that of art. The rhetorical power that these artists derive within the art community from their association with the scientific network is also of interest in this chapter. Perhaps this is a simple case of wanting access to the resources of what is currently the most valued form of knowledge practice, but it certainly also is a case of wanting to leverage important figures like Carrel to make points about the social power and mistakes of science.

Tissue Culture Training

In 1995, Joseph P. Vacanti's lab at Massachusetts General Hospital used a technique invented by his brother, Charles Vacanti, to create the Earmouse, which showed what appeared to be a human ear growing on the back of a lab mouse. A promotional image created by Vacanti's lab was initially used in a BBC broadcast of the Tomorrow's World program called "Test Tube Bodies" (1995). The sight of a mouse with what appeared to be a human ear on its back generated media frenzy as the image passed through the press and around the internet. Although the "ear" was produced using tissue culture, it was frequently misidentified as the product of

genetic engineering. Artists were not immune to the public conversation and reacted with a variety of artworks. A group of anti-genetic modification organizations published an ad in the *New York* Times using the image of the Earmouse, calling for an end to this type of genetic research. Like the institutions described in the *New York* Times ad, some artists mistakenly believed the mouse was genetically modified, while others were aware of the precise science involved.

More than just being embroiled in a series of reactions from the artworld, Vacanti was actually involved in training Oron Catts and Ionat Zurr in tissue culture techniques. As his final project for his design degree at Curtain University, Catts had proposed living furniture and had been studying technical possibilities for how this might be accomplished. In an interview (2007), Catts cringed when thinking about this project and what he now perceived to be the naiveté of his younger self, but he still found interesting the possibilities for reconfiguring our relationships to those things we use as if they are living. Catts and Zurr had also made contact with the already famous Stelarc, an influential body art performer, who was touring with his Third Hand piece, a mechanical arm that Stelarc could wear like a prosthetic and that allowed him to do various three-handed tasks (STELARC 2011). Catts interviewed Stelarc and proposed creating a skin by using living tissues seeded into polymers to cover the third hand. Interestingly, even early works by the artists who founded SymbioticA, which rely on photographs of scientific means, have some of the qualities of a copy; it was only after acquiring scientific skills that the artists moved into engaging directly with scientific issues in their artwork.

In 2000, an opportunity arose through their association with Vacanti which added to the two artists' credibility in working with scientists and science institutions. Vacanti's standing in the scientific community allowed the artists leverage in the science network, while his public notoriety for the controversial Earmouse associated them with a scientist known in the art network. By this time, they had made contact with the University of Western Australia, where they planned to put together a wet research lab for artists. By invitation, Zurr and Catts became residents at Vacanti's Tissue Fabrication and Engineering Lab at Harvard Medical School. While at Vacanti's lab, they learned tissue culture protocols for growing tissues over various polymers, and they also learned about the culture of science and how to communicate with scientists.

The SymbioticA Network

To understand SymbioticA projects, we need to locate them in context: in the bioart network. SymbioticA includes not only the physical resources provided on location or the scientist, artists, and technicians who are on site at any given moment participating in the production of biological artworks, pedagogical exercises, or experimental research. SymbioticA also acts as a central node in a network of loosely connected people and associated art practices. A quick consideration of the residents and speakers reveals that many of the major players in bioart have a connection to SymbioticA, and many other practicing artists are separated by only one degree, having trained with people associated with SymbioticA. This is even true for analysts of biological art. It is not simply that the

analyst would be remiss to ignore this site of biological art production; the analysts themselves have often visited or been involved with SymbioticA's work.

Biological Artworks

In order to reach a clear understanding of SymbioticA's practices, I will now introduce three important SymbioticA-related works of art. While SymbioticA and its affiliates have created dozens of projects, and no project can easily be considered "typical," these three examples have been chosen to give the flavor of SymbioticA work. MEART (Multi-Electrode Array Art) was one of the earliest SymbioticA projects and involved both scientists and artists working on a relatively level playing field. The second project artwork, Victimless Leather, was created using tissue culture techniques. The piece drew substantive media attention when news outlets reported that the curator "pulled the plug," allowing the tissue culture inside to die. I will provide the most detail about the final piece, "Pig Wings," since it involved both controversy and legal action. Like Victimless Leather, this piece employed tissue culture techniques, but the controversy was not about the ethics of tissue culture. Instead the artists attempted to critique the hype surrounding the human genome project, creating serious problems (including legal action) with the sponsoring gallery. Each of these examples reveals different aspects of the work done at SymbioticA and, taken together, they provide us with a basis to discuss some of the rhetorical and material resources that bioartists draw on in creating their work.

MEART

MEART: The Semi Living Artist (2001) was, in fact, a series of projects that were undertaken at SymbioticA by one of the earliest subgroups of researchers (Catts and Bunt 2008). MEART was unique in that it involved a balanced art-science collaboration, one that created both an installation fit for the art museum circuit and publishable scientific data. MEART consisted of collaboration not only between scientists and art researchers at SymbioticA, but also between SymbioticA and a neuro-engineering lab under the direction of Steve Potter at the Georgia Institute of Technology in Atlanta.

MEART consisted of three types of components mediated by the internet: wetware, software, and hardware (see Figure 4.2). Originally known as Fish & Chips, the initial design involved controlling a robotic arm by using goldfish neurons stimulated with a particular image created from electrical pulses. The arm would "draw" what the fish neurons (conducting across the internet and determined by a software tool) "told" it to draw. The results were four color drawings and problems about how we think of the mind and body.

The artists want to bring forward questions—not only about the use of fish for art, but also about what constitutes a fish mind and what agency we assign the fish neurons in relation to the drawings. Does the fish have a new body in the form of the robotic arm? What would it mean for a fish to have an arm, or to be creative? The artists and scientists have imagined a world of questions that this object can generate. Douglas Bakkum, a former graduate student in the Potter lab and MEART collaborator, published a series of articles about the potential fish neurons based on

data from the project gathered during art installations (Bakkum et al. 2004, 2007, 2008; Bakkum, et al. 2007; Bakkum, Shkolnik, et al. 2004).

The project series continues with Silent Barrage (2009), a new type of "body" for the neurons (in this case they are those of fish, and in later versions, rats) which can interact with the movements of visitors around recording poles, which have what look like seismic visual recording systems attached to them. Signals about the position of visitors in relation to the poles are transmitted to the fish neurons via the web, and in turn the neurons react, sending new signals to inscription devices on the poles which move up and down creating marking and a dynamic environment for viewers to again move around in. The movement signals are fed back to the neurons in Atlanta, Georgia.

Figure 4.2. MEART Robotic Arm. Versions of the project have been exhibited since 2001.

This piece is an excellent example of a SymbioticA project integrating the ideas and work of both artists and scientists. The project included more than a

dozen researchers from SymbioticA and Professor Steve Potter's neurology laboratory at Georgia Institute of Technology. Many SymbioticA projects that involve collaborations from scientists treat the scientists primarily as technical consultants, but this project seems to have involved scientists and artists at every stage from conception to execution. MEART was shown as a series of incarnations including Fish and Chips, MEART, and most recently, Silent Barrage. Each of these versions is slightly different; Silent Barrage, for example, is interactive, as people send signals to the neurons by walking among a collection of poles, but all deal with questions of minds interacting with machine bodies.

Victimless Leather

In the spring of 2008, SymbioticA gained considerable attention for its MoMA exhibit in the show "Design and the Elastic Mind." The project, called "Victimless Leather," consisted of immortalized cell lines grown on a polymer matrix to produce a miniature garment. The bioreactor that sustained the garment was invented by Arun Dharmarajan, a scientist who was then working at Johns Hopkins on perfusing rabbit ovaries for fertility research. Dharmarajan was able to provide the artists with diagrams of the system that he developed at Johns Hopkins before relocating to UWA. Catts and Zurr used this design, along with a specially made large chamber for the cells, which allowed for better viewing of the garment. However, this project involved less hands-on work from scientists-collaborators than a project like MEART, which divided up both design and execution tasks among scientists and artists.

At SymbioticA such works are known as "semi-living." This living art project raised questions about art, biology, and ethics. The MoMA show, according to one SymbioticA researcher, celebratory potential technological futures. The SymbioticA work stood out among the other displays, which were generally positivist, confirming science's incontrovertible knowledge about the world and technology's ability to improve it, and suggesting a bright technology-filled future. "Victimless Leather" became even more interesting when the cells began to multiply to the point of, blocking the nutrients tube. The museum curator decided to remove the nutrients that kept the cells growing—killing the artwork (Schwartz 2008). Although, according to Catts, the cells were growing in a manner that blocked the feeding tube so the artwork and the technician ceased to clean out its nutrient tube. In interviews, Catts (2007) indicated his delight that the semi-living piece concluded as it did, though he felt that much of the media portrayal took the concept of a laboratory-grown skin coat too literally, emphasizing the use of fetal calf serum as a means for creating so-called victimless products rather than the philosophical issues the artists were trying to bring to light. Catts seemed to find the media reports of the "death" of the coat sensational and wished that the media had concentrated instead on the use of animals to produce and sustain tissue culture. "Victimless Leather" can help us think about the agency of artwork and how we define life. It also exposes the way in which artists' and scientists' "rights" to work with such materials are understood. In "Victimless Leather," the boundaries of art and science are as muddled as issues of ethics and definitions of life.

Pig Wings

In 2000, Zurr and Catts were approached by the Wellcome Trust's Two10 Gallery in London to produce a work to "encourage critical dialogue about important culture issues" relating to the Human Genome Project (Zurr and Catts, Big Pigs, Small Wings: On Genohype and Artistic Autonomy 2005). The Wellcome Trust is the largest trust in the U.K. for funding biological research, and the Gallery is owned by the Trust. The invitation to Zurr and Catts came despite the fact that their work did not deal with genetic modification, but rather with tissue culture. Indeed the piece they produced, the "Pig with Wings" project, did not rely on modifying DNA but on tissue culture techniques.

This episode illuminates the character of the social group and gives us a basis for thinking about the role of the artist in relation to science. The Wellcome Trust was a major player in the race to create the first draft of the human genome, known as The Working Draft. The Trust spent significant money on the public funding of scientists to work on the human genome project, and so they had a stake in deciding whether there would be a framework favorable to patenting genetic products or whether the genome would remain public. The excitement surrounding the genome project was palpable. The legal constraints on quoting the correspondence between the Wellcome Trust and Tissue Culture & Art mean that I needed to rely on the account Catts and Zurr gave in their article "Big Pig, Small Wings" (2005). However, in a public announcement by the Wellcome Trust of how important the human genome draft was considered to be at that moment Michael Dexter, Director of the Wellcome Trust said, "A few months ago I compared the project to the invention of

the wheel. On reflection, it is more than that … …this code is the essence of mankind, and as long as humans exist … …is going to be important and will be used" (Wellcome Trust Sanger Institute 2011).

In 2000, Two10 Gallery sent a commission call for a show, "Envisioning the Human Genome," to TC&A. Perhaps they were contacted because of their association with Vacanti's Harvard lab or, perhaps, as the artists suggest, The Wellcome Trust was caught up in hype of its own making. As Zurr and Catts put it in their 2005 article for *Culture Machine*, "Everything biological gets confused with genetics." The artists understood that the Two10 Gallery hoped their commission would attract interest in artists for producing works that would support The Wellcome Trust's goals with respect to genome patenting.

The artists' response was to take the very public opportunity that The Wellcome Trust offered to undermine the debate on private and public genomes. They decided to critique the hype around the sequencing of the human genome, rather than addressing issues like the problems with patents for living things. According to the artists, to simply engage the issues set out by the Wellcome Trust would have been to become "passive agents" in the whirlwind of genohype, a frame of thinking in which the genome promises important changes in human life. Pig Wings was meant to critique the promises of what a future with knowledge of DNA would bring and the conditions under which their piece was commissioned. The project asks the question, "If Pig could fly, what shape would their wings take?" and explores the question with three sets of tissue-engineered wings. Stem cells derived

from pig bone marrow were grown over polymer scaffolding in the shapes of pterosaur, bat, and angel wings.

Their project would explore "the aesthetics of disappointment" by offering people flying Pig and giving them tiny wings. In order to produce the critique the artists desired, they engaged in the technical process of growing tissues over polymer as learned in Vacanti's laboratory. Creating an imaginary organ, one that had never existed, required the artists to make 3D computer models and grow pig bone marrow cells over polymers created from those models. The artists created three types of wings, each set of which fit easily into a petri dish: bird, bat, and pterosaur. This process is not dissimilar from the processes scientists and engineers are currently experimenting with to create actual organs for the body. 3D printers have been used to create polymers in the shape of sheep cartilage, then seeded with sheep cells and implanted into live animals, but SymbioticA's wings were never intended to be implanted. Rather they were intended to give the idea of transplanting organs from mythical creatures and to point out that what scientists (or in this case, art curators) claim may or may not be what we find when we take a closer look.

Perhaps not surprisingly, the Two10 Gallery rejected Pig Wings. Their advisory group felt that the project did not present, as the artists put it, "the public's opinion on the genome (Zurr and Catts 2005)." In other words, the artists' piece did not present the viewpoint the Wellcome Trust believed the public held of the human genome. The artists replied with a letter saying that they were sorry that their work did not reflect the committee's perception of what public opinion should be. The

Two10 Gallery replied that "perhaps they could have chosen their words more wisely," but contended that the artists were not correctly representing public opinion about the human genome project. Catts has noted (2007) that curators' understanding of what an artist should be is very different than most contemporary artists. To Catts, the gallery seemed to be looking for someone to advertise their wares (that is the human genome sequencing they had invested in), while according to Catts, most people understand artists as people providing reflections that lie outside the mainstream.

After considerable back and forth, the artists created a website discussing the controversy with the Two10 Gallery over Pig Wings and its relation to genohype. As is typical of artists working with ephemeral media, the artists' website cataloged the life of the project, including letters from the gallery. Three years passed and the fire around the human genome seemed to die down. In 2004, however, university lawyers contacted SymbioticA and advised that funding to other research programs at the university offered by an institutional body named on the artists' website might be jeopardized by the contents of the correspondence on their website. The artists took down their website, the lawsuit sealed all relevant correspondence, and it is no longer possible to read the words of the Wellcome Trust gallery on the subject except for a single curatorial statement about this project that appears on the Trust's website (Wellcome Trust Sanger Institute 2011).

In the artists' opinion, the Wellcome Trust defended its agenda and prevented dissenting opinions from entering or indeed existing outside of the forum it proposed, funded, and controlled. The artists expressed surprise at what they

believe is a misleading statement by the curator, Deena Jones (Zurr and Catts 2005). In her curatorial statement, Jones writes that:

> With an *open brief*, literal translations of the theme were not expected, nor did the artist have to reflect any specific 'look' or imagery associated with the Genome. . . . And intriguingly, although the artists had no idea how others were responding to the brief, there is a distinct *visual coherence* to the overall display achieved through the artists' combining a harmonious palette (including an over-riding incidence of salmon-pink) with translucency (Zurr and Catts 2005). [Italics added by Zurr and Catts.]

It is surprising that the curator is able to describe this exhibit as an open brief, when letters from the advisory committee make clear that the reasons for eliminating some artists were an "incorrect" vision of the genome. The curator's statement places a strange emphasis on color, rather than on content. This seems somewhat typical of the scientific view of what art consists of—that the work is about images created rather than representation. It seems that the harmonic palette mentioned by the curator was achieved by leaving some voices out. The Pig Wings, along with images created of them were displayed live at the Adelaide Biennale in 2001.

For the artists, Pig Wings demonstrated the messiness of life and its demanding requirements. Its installation requires a clean room in which to house the bioreactor containing the wings themselves. The bioreactor controls the temperature, pH, and gas levels, and the clean room gives the artists a place to replace the medium the cells require. The size of the clean room in relation to the size of the piece, if we consider the size of the wings only, is very large, suggestive of the large amount of scientific work and resources needed to produce these tiny wings. Part of this is due to the difficulty of keeping the wings alive and of moving

biological materials in and out of Australia. This story, particularly the legal portion of it, demonstrates how the platforms of power can silence non-consensus opinions. The Two10 Gallery had already engaged in forcible consensus creation by eliminating dissident outlier voices in the exhibit it produced, and it did so again through its threat to UWA funding.

In their subsequent account of the episode, the artists write that they felt that the Wellcome Trust had fallen victim to its own hype about the future of genomics (Zurr and Catts 2005). The gallery exhibit posed the post-genomics future as being either positive or negative. The Wellcome Trust organizers assumed that whether artists saw genomics as good or bad, they would certainly agree that possessing the genetic code would be important and raise culturally-significant issues that artists would need to address. They were, however, not open to the kind of critique of genohype which Pig Wings suggests.

Rhetorical and Material Practices

With an introduction to several SymbioticA projects in hand, we can begin to consider the ways bioartists shape the objects they work on and the context the objects inhabit to create critiques of different aspects of biological practice. The following sections deal with material and rhetorical practices. As discussed in the Introduction, I distinguish between rhetorical and material practices in order to emphasize that bioartists make cases for the ideas in their work by posturing in words and deeds and reinforcing their positions by working with materials to argue for particular viewpoints.

Each of these themes builds on the other, reinforcing the power of the project; what an object is materially and what we say it is cannot be separated. I will consider some of the aspects of SymbioticA's use of science as it attempts to critique science, and then move on to thinking about how engaging with living materials can draw out new aspects of work about living things. I will then discuss how bioartists deal with failure— both of logics about life and biology and of particular projects. Last, I will consider the skills bioartists acquire and the transfer of those skills among the bioarts community.

Using Versus Critiquing

For SymbioticA artists, a tension exists between using and critiquing science; a parallel tension exists between serving and critiquing science. In their conflict with The Wellcome Trust over "Pig' Wings," there was a controversy over who got to represent science, in this case, in the form of the human genome project. SymbioticA artists believed that their role as artists involved a right or even a duty to critique the powerful, in this case science and The Wellcome Trust's involvement in science.

Unfortunately because of the limited records, it is difficult to establish exactly why the curators did not select "Pigs Wings." Although, in this context, it is highly unusual that their work was not included after they had been invited to submit, it is entirely possible that the curators had other ideas about why the artwork should not be included.

Relying on the documents the artists put forward, the Wellcome Trust contended that the scientists it funded engaged directly in the production of scientific knowledge, while the artists it planned to contract to create displays for the gallery

were welcome only if they reproduced what the Wellcome Trust believed to be the public opinion on the genome project. Put more coarsely, as the artists saw it, the gallery wanted artists to advertise the value of the genome, whether they saw it as positive or negative. They could not imagine a position that engaged the genome project as anything except important. They believed that they understood genome science and even what the public would potentially think of it. At the same time they believed it would be valuable to put forth a critique through the voices and artworks of artists of the private genome interests' intentions to patent genes as opposed to the Wellcome Trust's supposedly more benevolent public science investments.

Natalie Jeremijenko, in conjunction with her contribution to *Paradise Now*, another art exhibit on the subject of the human genome, asks about this subject and answers herself: "What is it that the artists have that these corporate interests are interested in? It is not the art; it is the access to the public imagination" (Jeremijenko 2000). This access to imagination is at stake in many interactions between scientists and artists. Jeremijenko is suggesting that the way people direct attention to art is desirable to scientists and science institutions, so they will continue pursue artists for their role as perceived conveyers of relevant scientific information and creators of attitudes and imagined possibilities for science and technology. In this model, the artist always has a duty in his role as artist to produce work critical of power. For bioartists that power has been identified as science. In this case, she or he is at once under siege by powerful institutions to produce work that they perceive to be in the service of either public information or engagement. The Pig Wings project was about defying expectations: the audience's expectations of Pig with wings met with

tiny cultured tissues, and the Wellcome Trust's expectations of a pro-Genome Project piece met with a piece that questioned how artists are used for science-related public-relations.

Like Steve Epstein's AIDS activists, tissue culture artists at SymbioticA gained the knowledge of both jargon and skills which allowed them to create tissue culture art pieces. The story of "Pig' Wings" demonstrates two views of artists in relation to science. Both SymbioticA artists and The Wellcome Trust's gallery Two10 express beliefs about the role of the artist in contemporary science issues. The artists report that they find The Wellcome Trust's contention that the artists should represent the public's beliefs about science strange (Zurr and Catts, Big Pigs, Small Wings: On Genohype and Artistic Autonomy 2005). This is likely because of the artists' nearly opposite belief that the role of artists in biological materials is to critique science and the claims science makes for society. For The Wellcome Trust, art can be put to use in the service of science. The pieces accepted by the Wellcome Trust included work that concentrated on the problems and potential positive aspects for the public of genomic science. Catts and Zurr described this by quoting the words of Natalie Jermijenko, and applying it to their situation with the Wellcome Trust attempting to make use of the access artists have to the public's imagination (Zurr and Catts, Big Pigs, Small Wings: On Genohype and Artistic Autonomy 2005). But artists in the service of science is not at all the conception of SymbioticA artists, who are used to a world in which they collaborate with scientists, have access to scientific resources, and even hire scientists to work on their art projects or teach in their workshops.

As in the case of the Blaschka models, artists are often pictured as working for scientists. At SymbioticA there are role reversals, in which scientists and technicians work for artists, as well as cases of collaboration in which artists and scientists work together in collaborative partnerships. The former was the case when Orlan completed a residency at SymbioticA and commissioned elements of her artworks to SymbioticA-affiliated scientists and technicians. The commissioning of elements of the physical artwork is quite common, though the bioartists I interviewed had varying degrees of respect for the process. Some contended that it was not possible to be sufficiently "implicated" in the matters of life and death involved with this type of work without hands-on experience. To a science studies analyst this does not appear dissimilar from a scientist who conceives of a new experimental design and hires others—technicians, for example—to execute the design. In the case of Fish and Chips, the project appears to have been shared equitably with both conceptual input and technical know-how being contributed by people who identified both as artists and as scientists.

Enactment and Embodiment

Among the points of identity conflict and border policing in the world of biological arts, one issue is whether enactment and/or embodiment is important to this type of art. For example, the Summer 2008 issue of the science policy journal *Issues in Science and Technology* featured images from the MoMA exhibit "Design and the Elastic Mind," including Susana Soares' "Genetic Trace: New Organs of Perception" (National Academy of Sciences (U.S.), and National Academy of Engineering 2008). In this work, Soares suggests that genetic selection may now

rely on technology. She imagines additions to the human body to be used for collecting genetic information from others, like cilia for the ends of fingernails to collect dead skin cells during handshakes.

Imaginary projects like this raise the question of the importance of embodiment, which is also a factor in tactical media. Is: is creating the idea of these objects enough or must the objects themselves be produced? Some believe that some the practice of actually making bio-objects, as opposed to creating a conceptual representation of them with pictures or models, is central to bioart practice, while others believe that this issue is irrelevant to the impact of a bioartwork. "Design and the Elastic Mind" included examples of both kinds of works objects: projects that were primarily meant to spark thinking and conversation through schematics and images designed as conceptual pieces, and projects that were realized as working, living, or growing objects rather than representations.

In the case of "Victimless Meat" it is hard to imagine how the demonstrations of eating polymer-based meat could have been completed without creating actual tissue culture meat. An extension of this project "Victimless Cuisine" involved a chef cooking and a group of art connoisseurs and gallery visitors eating culture frog tissues. "Pig' Wings" does enact the difficulties of creating and supporting even a small and unusable tissue culture organ. Living works can be contrasted to fiberglass and acrylic works such as Patricia Piccinini's "We are Family," a 2003 work that became an Internet forwarding sensation. It shows what appears to be a pig-human, reclining and suckling her young. The visually-arresting piece stimulates questions about the origins of the being it depicts. Piccinini hopes that this work and

her other pieces that deal with potentially genetically- or scientifically-altered forms bring to viewers' minds what she calls the duty to care, and explains that we must look after the technoscientific bodies we create (Piccinini 1997). In a flurry of e-mail forwards, people inquired about precisely what Piccinini wanted them to ask: what is science doing with animals? Though perhaps she could not have anticipated that some users would be under the mistaken impression that her hyperreal sculptures were in fact living, she certainly intended to play upon our sympathies through their realistic looks.

Piccinini emphasizes our "duty to care" for our creations/scientific byproducts, but as her work is nonliving it works very differently from a piece like "Victimless Leather," which is shown live in the gallery and requires what Zurr calls an aesthetics of care. At the end of the day, the museum staff can simply turn off the lights, lock the doors, and leave pieces like "We are Family" at rest in the gallery. In the case of living biological works, the technical demands are much higher. Controlled temperature, sealed cases, proper heating, correct oxygen levels, and medium changing are often required.

In recent years, curators have become adept at dealing with new media and showing interactive and technical works in the gallery. These artworks often impose technical parameters on the gallery space and staff. At the moment, however, it seems that there is no system in place to consistently deal with biological works. Because of the technical demands, a philosophy that these works should be shown live in the gallery ensures that today's biological artist will need to travel with the artwork to meet its technical needs are met. This linkage between philosophy and

career demands is hardly new; for example, the Blaschkas' delicate and difficult work meant that they were the only artists able to create or repair their glass natural history models.

At the moment there is no consensus within the bioart community about whether enacting/embodying artworks is more valuable or interesting than simply representing ideas in a nonliving form, but it certainly is true that many bioartists have strong opinions on this issue and often call up rhetorical resources like ethics or honesty in representing life to the public. Some believe that representing the living in projects is sufficient (for example Piccininni's lifelike sculptures made of plastics), while others believe that in order to be authentic and ethical projects should contain actual living material (SymbioticA's tissue cultures) Though, even in these cases, sensitive materials are prone to death so the artists are often showing the dead, rather than the living. Living artworks vary widely from simply presenting living things as artworks to showing works that might be real (although this is made unclear in many pieces) or presented as living what the artist knows, in a Schrodinger's Cat way, that they are mostly dead, due to the conditions in which they have been placed in an art gallery. For example, "Tissue Culture & Art's NoArk" was shown as part of the "The Superhuman: Revolution of the Species" gallery display, but when the museum technicians turned off the electricity to the gallery at night, the bioreactor's contents were most assuredly dead (though the artists did not test them) as they were deprived of oxygen overnight.

In this world of contemporary art, lay viewers frequently assume the artist will be dealing with fictional and imaginative worlds, and this, too, raises questions.

Does it matter if it is what we say it is or imply it is? Meanings or resonances can be created around art materials, differentiating them from the meanings than they have in the scientific community, yet those dealing with scientific materials and displaying scientific equipment, as SymbioticA artists do in the case of "Pig Wings" and "Victimless Leather," are playing upon the power and belief in the "truths" uncovered by the scientific community in our society. This layering of meanings—drawing on the power of scientific protocols and techniques but displaying them in the art community as artworks—has the effect of absorbing the cultural power of science while at the same time critiquing the science which these works implicate. Works like these necessarily complicate the relationship between art and science, not simply by placing science artifacts in a new context, but also by reconfiguring their attached meanings. Tissue culture engineers are not expected to create new organs from mythical animals, and yet, we often suggest that scientists are interested in doing or exploring whatever is possible. The Pig Wings reaction allows us to consider for a moment the apparatus that makes credible the scientists' claims to do the seemingly impossible in the near future.

The Ironies of Failure

What counts as failure in the biological arts community is contested in the community. For example, Stelarc attempted to create an ear on his arm which would feed sounds through a microphone implanted in his arm to the web. Stelarc's failure to install a microphone in the "ear" because of an infection marked a change in plans that might be thought of as a failure, or at a minimum, as an unplanned event a researcher in anatomy would need to report to an Institutional Review Board (IRB).

Stelarc, however, does not frame this episode as failure, nor has he erased the online evidence of his initial plan to enable the microphone recording to be heard on the Internet. Stelarc has received much media and academic attention for his attempt to interface his own body more directly with technology, however, so in this sense the project might be considered a success.

The infection event seems to contradict Stelarc's central philosophy, that "the body is obsolete" and can be improved by technology (2009). The event of his infection did not dissuade Stelarc from his philosophy, and he might have had many opportunities before this to notice the apparent contradiction between his work and philosophy. His early art performances, (Stelarc 1976-1989) involved hanging himself by hooks from various platforms in public places. The piece created tension, quite literally, in Stelarc's body between his desire for the feeling of flying and the pain and distortion of the hooks through his back flesh, which enabled the flight. Critiquing the contradictory nature of this philosophy, however, only makes sense if we accept that Stelarc is speaking like a scientist, not like a character, who like the Yes Men is attempted a critique by demonstrating what happens when a set of beliefs are carried out.

Perhaps people in the bioart community are allowed to hold opposing beliefs, to say and do contradictory things, and not be considered hypocrites or even have other community members point out their logical problems. Confidentially, other bioartists are willing to point out the inconsistencies in Stelarc's position. However, it is equally plausible that Stelarc is merely playing a role that, as a performance artist, he has created a character that overlaps with his body who parodies the belief

that the body can be improved through technology. In other words, the seeming hypocrisy is Stelarc's character interacting with the artist's body to point out the impossibilities of the philosophy that the artist holds. In either case, like work at SymbioticA, Stelarc's work points out the messiness of life in the body.

"Pig Wings" exhibits its own ironies. The artists used the term genohype to critique The Wellcome Trust's eagerness to publicize the genome and its potential outcomes, but SymbioticA attempted to take advantage this public platform to bring attention to their political opinion of the value of the genome and to bring attention to their artwork. Ironically, "Pig' Wings" is a demonstration against hype, but the articles and letters and the piece itself are themselves about drawing attention to a different opinion. This political dimension is very present in some strands of contemporary art. The "Pig Wings" episode shows how artists can subvert and react to the expectations that the science world and even galleries have for science-engaged artwork.

Skilling

Another identity-related issue is how these artists and collaborating scientists obtained the skills to create their bioart projects. As we have previously seen, bioart progenitors Zurr and Catts were educated in Vacanti's lab at Harvard and currently produce artworks at the University of Western Australia, School of Anatomy and Human Biology, SymbioticA. Owing to Australia's strict regulations on the movement of living materials (both in and out of the country as well as across state lines), displays of their artwork must often be created on-site. This is sometimes done through local universities and other research institutions or by

purchasing local materials that are either easily put together or can be put together in specially created laboratories inside the museum. In either case, technical skill is required.

The politics of these artists involve an advocacy of the democratization of science. They are committed to a do-it-yourself (DIY) view of science and tissue culture, in particular, and to attempting to transfer those skills in workshops. The reason for this belief probably stems from the artists' early experience with at-home experimentation. Trends toward DIY, particularly DIY synthetic biology and its relationship to amateur work, initially raised the hackles of many conservatives and the interest of the FBI and homeland security (Pollack 2010), but was recently approved by the Obama administration (Saletan 2011). Catts once showed me a tiny mold-covered chair he had created in a home experiment and which he had kept on top of his refrigerator. However, there are some serious problems with this claim for do-it-yourself skilling since the artists' major projects were not created in basement laboratories. The original artists had excellent training and resources before they ever showed their first work, and they have been able to pass on, both tacitly and through written protocols, the knowledge and skills it takes to have what Zurr explained to her bioarts class as "feeling for tissue culture" (2009). In their workshop held in Melbourne in November of 2009, Oron Catts and SymbioticA laboratory manager Gregg Cotzens taught participants to make do-it-yourself sterile hoods. Later, students were directed to use the pedagogical sterile hoods located in the teaching laboratory. After being put together and reviewed by the workshop leaders, the hoods were set aside.

When I asked Catts why the SymbioticA workshop participants did not use the DIY hoods, he smiled incredulously and made clear that he was unconvinced that these hoods would actually work. Indeed, even the best hood seemed dubious to me. Its airflow seemed more like a simulation of a scientific sterile hood than something that could be reasonably worked with by a beginner. We might think then that the real purpose of this pedagogical workshop was not to teach actual DIY skills to create a sterile hood but instead to symbolize (and simulate) a laboratory environment for direct participants on the Internet, which has scores of manuals on this subject. Or, perhaps participants were to learn jargon and basic etiquette of the laboratory in hopes that they could gain future access to the lab. In fact, Catts pointed out that it would take many visits to the lab before students could be involved in work that involves tissue culture and biological arts. These visits would encourage sustained relationships between the scientists and the learning artists. It seems that the biological arts community as a social movement includes a rhetorical appeal to an everyman science, an appeal that does not, however, include acquiring the necessary skills to do science.

Engaging the public and specifically other artists and democratized science is a core political ideal at SymbioticA and for many other bioartists. The fact that these artists' politics do not match the claim that everyone can be involved with technical practice, might simply be an artifact of a one-week workshop, but it seems that the power of suggestion that anyone (even an artist) can learn the skills of tissue culture is meant as a thought experiment to provoke the conditions of engagement by

suggesting to people that they can know, contribute to, and critique scientific knowledge.

The laboratories in which SymbioticA artists work have caused them to develop certain attitudes toward ready-made science equipment. For example, during my tour of the SymbioticA lab spaces, Catts expressed his disdain toward what he terms "white goods," by which he means commercially produced equipment which separates the user from the process. Catts complains that scientists and technicians do not need to know how the equipment works. This black boxing is problematic for him since it creates distance from the life that is being manipulated in the lab.

Catts' recognition of the slick designs of some scientific equipment probably flows from his training as a designer and his attention to the other resonances besides function that an object may offer a user. Catts complained about the slick red convertible-like equipment as he pointed to highly stylized lab machines that processed samples in UWA labs and he made fun of the tiger image embellishment on the Melbourne lab incinerator. Most interesting was Catts' critique of biology equipment that gave the user the sense of a clean and easy work with a life form. He described bioreactors that reminded him of CPUs in which specimens could be loaded and left for an appointed length of time. To him this just made life look too easy. He connected this to the metaphor of the genetic code: these computer-like biological machines were depicted as able to process life forms into data through a strange metaphoric mapping of life as code. With this in mind it is somewhat easier to see what is at stake for SymbioticA when training new bioartists and encouraging

them to try different DIY sterile hood designs. In the end, however, it is difficult to know what we should make of hoods that are non-functioning representations of the ideal of access to tissue culture techniques for 'everyman.'

Knowledge and Aesthetics

Marxist literary critic Terry Eagleton writes that aesthetics is about filling in the gaps in Enlightenment power. As he puts it in *The Ideology of the Aesthetic* (Eagleton 1990), "It is as though [Enlightenment] philosophy suddenly wakes up to the fact that there is a dense, swarming territory beyond its own mental enclave, threatening to fall utterly outside its sway. That territory is nothing less than the whole of our sensate life. … [The aesthetic] is politically quite indispensible: for how can everything that belongs to a society's sensational life-'experience,' be allowed to fall outside the circuit of its reason?" Eagleton's understanding of aesthetics as intimately related to the body and yet outside the Enlightenment gaze is at stake at SymbioticA. The idea that there is a "messiness to life" explored in these works (Eagleton 1990) is code for the life of the body and lived experience. SymbioticA artists work to make this uncontrollable quality explicit; their project treats the scientific community's view of biotechnology as a form of the high modern notion that technological systems might completely control nature, in this case biology. SymbioticA artists' work (for example Victimless Leather) often reacts to this sense of control over biology by trying to re-complicate the living, by introducing concepts like aesthetics of care and by pointing out the difficulties and messiness related to dealing with life.

If we agree with Eagleton that aesthetics is an attempt to confront what The Enlightenment ignores. If the aesthetic is political (the uncontrolled part of society's experiential life), science studies should take the aesthetic into account when we apply our tools, which are already honed to deal with the experience and practice of science and technology. Two key points come into focus when we view aesthetics in this way. The bid to control society's knowledge sphere is an ongoing project of, in Stenger's (2011) terminology, rationalists. In the case of "Pig Wings," this takes the form of scientists' attempts to harness the work of artists and their access to the public's imagination are intertwined goals. This expectation of the role of artists with regard to the Enlightment project is part of the scientists' rhetorical posturing to assure the public that all is well in hand, even the messiness of life. If science offers the public "what" and science studies offers "how," then the aesthetic offers the unexplainable content of experience.

Conclusion

SymbioticA artists gather material and rhetorical resources to make their projects count as critiques of science, while employing scientific methods, and yet they position their work as artistic practice. SymbioticA's goals of drawing attention to the way biology works with living things, focusing attention on biotechnology's corporate control, and diagnosing utopian views of the possibilities for science are made possible through the use of scientific materials and practices, which both bolster their position as knowledgeable practitioners and attract attention to their political agendas.

The bioartists at SymbioticA have created a fused identity, one that allows them to move biological practices into art galleries and make political points about science using artistic logics. These bioartists invoke influences that include both artists and scientists, to training in both art/design programs and tissue culture laboratories. Works like "MEART" bring together ideas from neurobiology and robotics to question the nature of creativity and the nature of minds. "Victimless Leather" sets up questions about the use of living things as gallery objects and about the ethical issues involved in biological practices as common as tissue culture. In contrast to the idea that artists are parasitic on science, "Pig Wings" reveals how artists can be employed to hype scientific ideas and how artists can react to such attempts to enroll their work in other agendas. Like attempts to show how science functions by using concepts from sociology, history, philosophy, anthropology, and literature, these artists are attempting to use their practices to engage deeply with the form and content of scientific work. This chapter has revealed how bioartists subvert the use of biological materials to make their points. The categories of art and science are used by SymbioticA bioartists to create the conditions for critiquing biology. Works like those at SymbioticA can be considered science studies by other means; that is, these works engage some of the same issues that science studies engages but do so not by publishing papers but by vesting their ideas into physical and tactical objects.

CHAPTER 5: CONCLUSION

Isabelle Stengers (2011), in an address to the Society for Literature Science and the Arts, described the pressure on the "non-rational" world from the "rational" world as continuing to grow, and proposed that modernity has become associated with various forms of scientific rationality. Stengers distinguishes between various scientific subjects to the point that the non-rational is relegated to a non-civilized status. In short, the non-rational is seen as inefficient and irrelevant, instead of offering the values that in times past would have signaled taste and sensibility. Stengers is particularly concerned that an embrace of the rational may signal the invalidation of other discourses. Indeed it is the rising power of the sciences to colonize other forms of knowledge that science studies has the potential to comment on. Like early science studies work aimed at physics as the heart of science, our tools may now be employed to explain other forms of knowledge, and what better place for this inquiry than in the heart of the non-rational: art. For Stengers, the subjective could return as a viable site of knowing, given the correct social conditions.

Wading out into this debate with the tools of science studies, it is possible to offer some reconciliation between these embattled positions. For in science studies, knowledge production need not be scientific and the concepts of rationality and objectivity can be given histories. Methods can be devised to see science and art as not parted irrevocably. Indeed whether scientist or artists like it or not, institutional changes are afoot which bring this question to the fore. As the research Ph.D. takes hold as the currency of education in art, increasingly new questions will be asked

about the role of art in research. For example, a recent development has been the interaction between artists and institutional review boards around definitions of "research" in the arts, as examined by myself and Dehlia Hannah at the Society for Literature, Science, and the Arts conference panel "Researching Sci-Art: Critical Engagements with Ethics Boards" (2011). More difficulties of this type are sure to follow.

The categories of art and science are continually being constructed by rhetorical and material means. Whether the case in question is planted firmly in the category of art or science or whether it is a mixed case, like those in this dissertation, ideas and materials that invoke ideas are constantly being configured to achieve actors' political-aesthetic-knowledge-making goals. Sometimes these goals involve the actors working very hard to "count" their creative products as art or science, as in the case of the Blaschkas, who wanted their work to be accepted in the scientific community. This acceptance was important for the glassmakers' livelihoods (although they might well have made money through other glass shaping ventures), and it was also crucial to their social acceptance as natural glass artisans. The Blaschkas literally contributed materially to science: their models were crucial and cutting-edge apparatuses for understanding organisms. For the Blaschkas, contributing scientific models simultaneously accomplished their economic and identity goals, so that having their work categorized as "scientific" was a means to fulfill both goals.

The work of tactical media artists is different from this way of thinking about the flexibility of categories. While the Blaschkas understood that a sort of boundary-

work, that is, drawing their own models inside science boundaries, was required to make their models appealing to scientists, tactical media practitioners intentionally work at the boundaries and leverage the categories for their political ends. Tactical media artists talk about and demonstrate that they consider art and science as categories. They both ignore boundaries and play upon them to attract attention for their political causes. SymbioticA artists similarly invoke political and ethical goals for their work, but they claim to want to maintain the boundary between biology and art, even while creating projects that dissolve that boundary on many levels.

As presented in this dissertation, acts of questioning involve disputing the separateness of art and science. There is not a single type of transition or traceable change in how the objects come to fit the definitions of art and science. These two categories continually change as a result of being employed by actors for specific purposes around the objects. For example, during my interviews with tactical media artists, some artists stated that calling their work art or science was irrelevant. All that mattered to them was that people were exposed to their ideas, which often related to political issues, particularly critiques of capitalism.

In practice, definitions of art and science are moving targets. They oscillate between the idea that art and science are expressed and symbolized through the objects they produce and the idea that art and science are ways of attending to an object, so that the same objects can be subjected to the practices of either domain. In the case of the Blaschka glass models, when placed in their science context, their curator at Cornell hopes to garner attention for a political cause—marine conservation. While the Blaschkas certainly imagined art uses for their models, it is

hard to imagine that they had an inkling of this particular use, since it involves enrolling the public in the work of protecting the environment, particularly oceans. In the art museum setting the models are treated as examples of craftsmanship from their particular historical period. While the Blaschkas talked extensively about their craftsmanship, the concept of craft as counting among the high arts is a relatively new phenomenon, which became prevalent after the rise of the avant-garde. This usually involved a return to the skills of the artist and as a political act related to the elevation of women's craft works to art status.

At other times, a conflict arises between the use of a network in a project and the project's ability to critique that network. In the case of tactical media practitioners, for example, this plays out in the work of the group Pre-emptive Media in the project AIR. On one hand, they, like many involved in community-based citizen science projects, want to create and disseminate knowledge about air pollution, which requires that they rely on some scientific principles and engineering protocols to create functioning air quality sensors. On the other hand, they want to use their handheld sensors to undermine the scientific standard of stationary sensors and raise awareness about the flaws in the government's air quality monitoring system. These practitioners employ the technical signs and the scientific language of air quality. They insist on their right to work with materials and to verify ideas that are conventionally understood as inherently scientific, but they do so in order to question the categories they work with and to reflect on this boundary.

Identities and Skills

The rhetorical and material methods by which actors make their work count as art or science function differently in different contexts. Two of the major themes in each chapter, identity and skilling, particularly warrant direct comparison among the three case studies.

Identity/Characters/Mythology. Bloodlines were the ultimate marker of identity for the Blaschkas. SymbioticA artists have chosen a lineage that emphasizes both directions of influence between science and art in the persons of Alexis Carrel and Edward Steichen. Tactical media practitioners invent histories and characters in order to draw attention to their political causes. Throughout my case studies, the role of identity and the characters people style themselves to be in order to be accepted in science and art communities have been prominent.

Tactical media practitioners sometimes create fictive roles to forward their causes, but the Blaschkas also selected identity markers in order to gain acceptance as observers of the natural world. While different in kind, these actions are not different in cause. Both engaged the science of their day, if for different purposes. Tactical media artists position themselves ironically and satirically to parody the centralized control over knowledge, while the Blaschkas attempted to extend their representations to meet scientific demands. Bioartists fall somewhere between these two positions. While they do emphasize aspects of their identities to position themselves as artists or scientists in different contexts, with few exceptions they do not create entirely new characters to play as part of their artworks. Certainly bioartists do dress and use acting skills as part of their projects, but generally the

audience is made aware that they are seeing an act. In all these cases identity management plays a crucial role, as actors position themselves and their work in relation to the categories of art and science.

Technical Aspects/Skilling. Considerable technical skill is required from all the artists in this dissertation. The Blaschkas not only needed to master lampworking and eventually the details of creating colored glass; their models also required scientific technical skills. These skills included observational abilities, scientific drawing, and the ability to emphasize what their scientist-customers would consider the salient features of each organism in order to produce scientifically acceptable models.

Tactical media practitioners also required a host of skills varying by project. These artists require promotional skills, as well as conceptual abilities and in some instances acting skills and the ability to create satire or a good joke from the often serious matters at hand. Many of these artists also need to be familiar with the legal rules that may apply to their work. Additionally, tactical media practitioners need the technical skills to make their websites run, pigeon with backpacks to fly, and gels to run. These scientific and engineering skills must be translated for audiences, who rarely have technical skills. Many projects are oriented toward community understanding, and these projects also then require skills for working with the public.

Bioartists face similar hurdles. They want their scientific projects to translate into ideas for audiences, and must shape them to that end. But they must also navigate the often complex rules for safety and ethics boards, as well as marshaling

the expertise in gathering resources to conduct tissue culture or other living matter. In addition, they speak the language of science in order to fruitfully interact with the scientific community and are familiar with a myriad of lab work protocols.

For actors who wish to work at the border or even undermine the separation between art and science, the proper skills are no small matter, as they must acquire skills valued by both communities. Being recognized as having an eye for medusa observation or a way with tissue medium allows these artists to work credibly in science and in art.

Rules for Separating Science and Art

We can use a number of rules to distinguish the artistic from the scientific, but my analysis in this dissertation complicates them. Though it is possible to pick examples that would adhere to particular rules, it is easy to think of others that would violate them. This is not to say that the worlds of art and science are identical, but rather that their separation is constructed through actions in particular contexts. If art and science are often similar pursuits, then why are the people participating in each of them so convinced that they are different? And in what ways do they emphasize that difference? My answer to this question is that there are social factors that unite people behind the art and science banners. People point to a host of reasons for why they are artists or scientists, and it is important to take note of some common reasons why people feel that the difference between art and science is clear.

The recognition that the art-science boundary is constructed does not guarantee that specific results will be elicited. Just as gender has not evaporated

under the work of feminists on the construction of gender, it is unlikely that any amount of science studies work or number of examples will close the gulf that so many people are working to create between the arts and sciences. Deconstructing the similarities and differences understood to be the cause in specific examples, however, can provide insight in context-specific constructions as well as the uses of this boundary.

Science studies has shown that the idea that scientists work with things while artists work with representations is not accurate: scientists spend their time working on representations too. Both scientists and artists are often engaged in telling us something using something else. We might do well to take note of some common mantras used to separate the two and think about why those arguments are effective for putting forward the separation agenda, as well as to consider the work that has to be done to hold the two together: both are constructions that require effort to maintain.

Different materials. It could be argued that science and art make use of different materials and subjects. This, however, is impossible to maintain in the face of the use bioartists have made of microscopes and the use scientists have made of the Blaschka models. The separation of types of materials seems only to hold up under the conditions of caricature, and then only in certain contexts. What we know in science studies about the way scientists employ materials has gone a long way toward undermining the notion that scientists directly read from a material "book of nature." Rather, their interaction is more like the representation associated with classical artists, who are thought to study a subject and then re-present it in another

medium. At the same time, the stereotypes of the artist with a paintbrush and the scientist with a microscope persist for those outside of art and science worlds, respectively. Dismissing these ideas as confused public impressions may be to dismiss the very sociological factors that are at work here, as people's beliefs about what is or can be science or art may crucially give up or manipulate those categories' meanings. For example, some artists wear lab coats intentionally to play on the authority vested in the garment, while other artists perform complex experiments in the traditional avant-garde artist garb, all black. Bioartists and tactical media artists make use of stereotypical emblems of science, so that even when they challenge those stereotypes they reiterate them (Lynch, Personal communication 2009).

Different training. Many tactical media and bioartists have backgrounds in science and technical fields. Oron Catts and Ionat Zurr learned tissue culture directly from a leader in the field. Rudolf Blaschka studied natural history, along with drawing and glass blowing. Many of the scientists who exhibit images in galleries, for example the nanoscientists involved in the Materials Research Society's semi-annual art competition, have little or no artistic training. It is possible simply to dismiss the MRS's art competition as amateur or even non-art, but the same argument could be made about bioart, as there are still many who would argue against it "counting" as art, particularly in commercial galleries. Moreover, there are probably those who would dismiss the training of Catts and Zurr in tissue culture as incomplete, thereby challenging their right to do science, since they do not hold scientific degrees. However, at least among the scientists with whom they share laboratory space, there seems to be no disagreement that they are quite capable of

the scientific practices required to maintain living cells, though not even the actors themselves would call their work 'science.' Training then presents a bit of a quandary; with SymbioticA scientists working on art projects and scientists engaging in art competitions, it is not clear where dividing people by using their backgrounds can take us in terms of a rule by which to divide up science and art.

Different relationship to the state/power. While artists might like to picture scientists as servants of state power, science and the state have a more complicated relationship. Many artists in the tactical media and bioart movements are critical of other artists' relationships to both science and state power. For example, in the case of the Wellcome Foundation and Pig Wings, bioartists felt that they were being led to produce a two-dimensional sense of genomics: whether the genome should be under state or private control. These actors believed that it was their role as artists to critique this setup rather than to support one side or the other. For similar reasons bioartists also critique those who present images meant to celebrate science and discovery. They see the role of artist as necessarily involving a reaction to science beyond admiration, though this is hardly a voice in unison. There are dissenters to this vision of the artist as standing against state and corporate powers (Turner 2006). Fred Turner argues that artists have long been agents of state power. Turner points to a specific example of the relationship between Black Mountain artists and the emerging automation of production tasks as executed by American capitalists to suggest that artists are not outside of state power, but indeed may act to reframe or even exert pressure as new technologies are put into practice.

Based on my interviews, it seems that the artists' negative reaction to the suggestion that they are science communicators or simply creating beautiful objects from scientific data is built on their collective identity, which demands that they engage in works against state and corporate power, including the power they see vested in modern science. The Blaschkas surely would not have tolerated the suggestion that they were creating objects meant only to bring pleasure to the eye: they were contributing to how marine animals were understood in the scientific community. Bioartists object to characterizations that suggest that they are auxiliary to science or doing work to translate scientific subjects to the public: these artists aim to contribute to debates around and inside of science. Tactical media artists openly state that their goals are political. While we might ask if they, in fact, would consider work successful that was done by other means (would a simple protest or petition be considered as good?), they do make it clear that their first priority is reaching people with stories that forward their political agendas. These agendas are frequently anti-corporate, opposing state power, or against the science-state complex. Like bioartists, they see their role as artists as necessitating critiques of power. These critiques sometimes require that the actors involve themselves in legal actions, directly interfacing with state power.

The Blaschkas' relationship with power involved their economic concerns and the introduction of style into the scientific objects they made, as one of their foremost goals was to sell models inside the scientific community. However, the Blaschkas also wanted to contribute to scientific knowledge. It was important to them not simply to copy the illustrations of scientists but also to do hands-on

observations in their own gardens and in the field. The Blaschkas understood themselves not simply as working for scientists but as contributing to scientific knowledge through their observations and by spreading their findings to the community via their models. They were participating in a kind of revolution, however, in making space for themselves as glass artisans in the new world of natural history. The power the Blaschkas were working with is that of the scientific community, which they wished to both contribute to and make a living from. The Blaschkas' agency extended beyond their roles as businessmen marketing their work to scientists. For the Blaschkas the role of artisan was more than to serve the scientists, they understood themselves to have particular expertise in observation and "tact." They contributed directly to the scientific enterprise by providing the material means for scientific study and by introducing style elements, notably from art nouveau and photorealism, into the representation of specimens.

Aesthetics in Context

It is unlikely that, when you stand before a work like MEART or a display of glass sea creatures, you are thinking of identity work that SymbioticA or the Blaschkas engaged in to have their work accepted as science or art. Instead the focus is on the experience of these works, an experience that Eagleton (Eagleton 1990) is referring to when he connects the aesthetic to the political. This sense of the political is not the political of tactical media's focus on gender issues with tough-talking Barbies or satirical websites. It is, instead, the politics of attesting that there is something outside of scientific knowledge, outside of what Eagleton calls Enlightenment knowledge and connects to elite values.

Attesting to what is absent in rational lives, what TC&A would call the "messiness of life," is precisely what these artists are up to, and it is what we admire in NoArk and other tissue culture pieces. If we were admiring their accuracy or correctness as science, dozens of other descriptions or configurations of objects would do as well. We are admiring their aesthetic in Eagleton's sense: the fact that the messy is left in and crafted. There is something more there than what is required.

The Blaschka models can be seen in two ways with regard to this definition of aesthetics. The models can be seen as containing something later recognizable as style. Perhaps this style was an unnecessary ingredient in the models and did not affect their acceptance as scientific—that is, there was an element of subjectivity in the models which a community of people seeking objectivity tolerated. Or perhaps more likely, what counted as an accurate model was dependent in part on the Blaschka's chosen aesthetics appearing to be correct to the scientific eye in this context.. Alternatively, the style of the Blashcka models can be seen as so integral to the their ability to be interpreted as representations of marine life that we cannot imagine separating the lifelike qualities that the Blaschkas imbue their work with from the scientific points the model buyers were after.

Though I have not dwelled on it in each chapter, the relationship of the pictorial and the real is present across the cases I have explored. I mention it here because of the frequent confusion about the nature of "realistic" depictions in both science and art. The pictorial in art, like the models the Blaschkas produced, is sometimes recognized as being realistic in science, but the fact that a particular style is considered realistic or acceptable as a means to convey objectivity is not a sure or

stable thing. Both Patricia Piccinni's sculptures and the Blaschkas' models are able to fool the eye, particularly in photographs, into believing that something "real" rather than representative is happening. The Blaschka models are also pictorial in the way they purport to resemble real marine specimens, while deploying the conventions of art nouveau. In the case of a piece like Vanouse's, the artist is also playing with pictorial possibilities, but in an attempt to wrestle with the meaning of images (in this case from DNA fingerprinting) that science produces. Bioartists create pictorial objects that look like something symbolic (for example, Pig Wings) but they do not focus on the thing they actually want to represent – the living cells. In the case of a work like NoArk II (Catts and Zurr 2009), the viewer familiar with their work will deduce that the apparatus is a bioreactor of some sort, but the artists are working with the invisible. The care for the cells is made visible through feeding nutrients and temperature gauges. The authenticity of their artistic creations does not come from resembling something real, but from the medium or form through which it is constructed. In this way bioart might be said to be formalist as it draws value from its form, though certainly it is not formalist in the sense that all one needs to understand of the work is included in its form. In fact, often a fairly sophisticated knowledge of biotech is necessary, not only to understand the medium or creative process, but also to understand the cultural critique the work expresses about the role of science or science's relationship with corporate and state interests.

Certainly there are other ways besides the pictorial to understand tactical media or bioart. A project like MEART involves creating the materials to support a thought experiment: what if fish neurons could control a robotic arm? What would a

fish draw? Here the emphasis is certainly not on the drawing that the arm creates but on the cyborg configuration of fish tissue and a robotic arm. It does, however, still play on Eagleton's idea of the aesthetic. Seeing the robotic arm scratch back and forth over a huge sheet of paper, while knowing that the arm is controlled by impulses from fish neurons, is an experience that is different from either reading about it or simply imagining such a machine in the abstract. MEART can be reduced to publishable scientific data about neurological impulses, but it is also something more, and that left-out-something is the aesthetic.

Further work might include more science-oriented art and science projects. Initially, when I selected the Blaschka models for study, I thought that I would learn that these artists identified more closely with the scientific community. It seems, however, that they derived a large part of their power as skilled glass workers from emphasizing their bloodlines and glass artisanal backgrounds. A different case study that researched, for example, an art display created wholly by scientists might give yet another perspective on issues of identity. This would contrast interestingly to the scientific publications based on the MEART project, which emphasize the nature of the experiment and larger philosophical questions related to scientific instrumentation rather than the specifics of individual data points about the impulses of fish neurons.

Beyond the aesthetic is style. Style is about matching the needs of the moment: channeling the extras of aesthetics into a recognizable format that orients the viewer and creates a visual language. In the chapter on the Blaschkas' models, I have discussed the ways that style was employed by the Blaschkas to create models

that would be acceptable in the scientific community. Style is required for the models to be interpreted as science. Try as we might to pare down the Blaschka models to only rational ideas, the non-rational is present as style in the form of colors, form, and positioning of the models. Style is not simply auxiliary, but is part of what makes a Blaschka model "correct" in terms of contemporary conventions.

During the process of studying these projects, it became clear that just as the separation between art and science is constructed, so are the attempts to bring the two together. Since I began my dissertation research, kind friends have helped me collect many, many articles on the intersection of art and science. Among these are a number of pieces from *The New York Times* and *Discover* magazine, as well as a special series from *National Public Radio* (Overbye 2011; Eakin 2003; Wallace 2011; Panek 1999; Glausiusz 2005; Strickland 2009; Buchen 2008; NPR 2011). A large portion of these were news articles, so perhaps there is sensation around the subject, though as the case of the Blaschkas shows, the art-science interface has been with us for a long time. Some of these projects were more coherent or successful than others, but generally a great deal of effort has been spent to bring about and position these projects. Binding together or taking apart art and science happens only under the efforts of actors with particular political goals.

In the case of art and science, the relationship between materials and labeling schemes is one of deep entanglement; the problem of which came first, the material or the language is intractable. The cyclical production of the definitions of art and science through materials and language, and the inherent reliance on what people say and make to constitute each, mean that neither is ever fully stabilized.

The science studies scholars communities(in a light not dissimilar from many scientists' perception), have seen artists as "underlaborers" when brought into contact with scientists, these cases complicate the relations between scientists and artists. Like science studies scholars challenging the whiggish history of science, the contemporary art movements I have examined here challenge visions of art's relationship to science. Further, they offer science studies scholars a chance to open concepts of knowledge hierarchies and examine the work of artists in relation to science.

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